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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : G06K 9/22

A1

(11) International Publication Number: WO 94/10652

(43) International Publication Date: 11 May 1994 (11.05.94)

(21) International Application Number: PCT/US93/04237

(22) International Filing Date: 6 May 1993 (06.05.93)

(30) Priority data:
07/968,110 29 October 1992 (29.10.92) US

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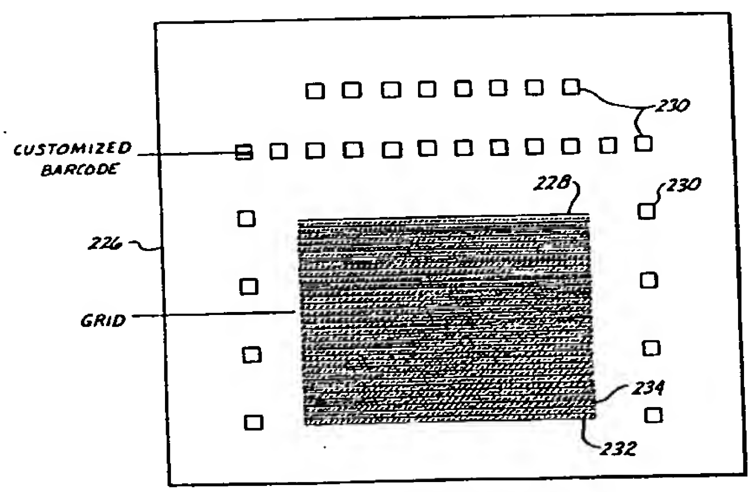
(81) Designated States: JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: APPARATUS AND METHOD FOR A TEXT INPUT SYSTEM AND UNIVERSAL COMPUTER INPUT DEVICE



(57) Abstract

A scanning pen (10) is used in combination with a transparent ruler (36) which guides the movement of the pen (10) over a line of text. An indicia bar (46 and 50) along the length of the ruler (36) independently establishes the time rate in which the pen (10) is manually moved independent of whether the pen (10) is advanced, stopped, or reversed to generate a pixel map. A dictionary (208) of different symbols is established for identification of scanned graphic patterns. The scanning pen (10) may be used either as a point-and-click bar code reader (222), a bar code scanner (224), mouse (218), handwritten data (220), or text data input device (216). Bar codes may be user-defined or standardized and may symbolize alphanumeric data or macro instructions. The scanning pen (10) uses a single linear detector array (52) which can either be used in either a stationary input mode, a linear scan mode, or a two-dimensional mode. In the two-dimensional mode, a timing grid (228) with horizontal (232) and diagonal timing bars (234) of distinguishable thicknesses is employed to track the manual movement of the scanning pen (10).

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APPARATUS AND METHOD FOR A TEXT INPUT SYSTEM AND UNIVERSAL COMPUTER INPUT DEVICE

Background of the Invention

1. Field of the Invention.

The invention relates to the field of input scanning devices for computers and in particular to a pen-like scanner for selectively reading printed lines of alphanumeric characters and other symbols for optical character recognition and to an off-screen input device having the combined functions of a scanner, mouse, handwriting input and both a scanning and point-and-click bar code reader.

2. Description of the Prior Art.

Optical character reading scanners typically scan a printed page to store a dot pattern either through a raster scan or through a pixel map corresponding to the alphanumeric characters which appear on the page. Thereafter, the dot pattern is subjected to software controlled pattern recognition algorithms for correlating an ASCII code to each identified symbol.

The limitations of such prior art techniques are many fold. Firstly, the scanning mechanism is generally large, complex and expensive since the number of data points which must be read are considerable. Secondly, the amount of memory which must be reserved for storing the data points pending its processing is correspondingly substantial. Thirdly, the amount of computation power and time required to make reliable pattern recognitions is considerable. Typically, such systems cannot scan on a real time basis or at high rates of data input. Furthermore, the reliability of character recognition achieved by these systems is often poor. The increase of reliability can be achieved only by substantially greater expenditure in terms of hardware and software costs and complexity. It is doubly difficult to provide reliable character recognition in small, inexpensive and hand held devices for all of these reasons.

Hand held scanners are presently viewed to be of limited application. The width of a usual scan is usually less than five inches which is adequate for magazine articles, but not much else. In addition the user must have a very steady hand. Some scanners are difficult to move when alignment is critical. This has led to the

perception that hand scanners will be abandoned in time for full-size scanners. See, **Stafford**, *"Today's Scanner Market is a Tough Act to Follow,"* Business Machines, p.37 et.seq. Nov. 1991.

Devices for performing multiple types of input functions for computers are known in the art. **Jones et al.**, *"Combination Mouse, Optical Scanner and Digitizer Puck,"* U.S. Patent 4,906,843 (1990) shows a hand held input device which is operated as a mouse to move a cursor in a display, used as a hand held optical scanner for entering computer characters or graphic information from a worksheet, and used as a digitizing puck for tracing and digitizing lines or curves on a worksheet overlaid with a digitizing pad. Unit 9 within housing 10 is provided with function keys 12 on its upper side. The unit can be used without one of at least two heads plugged in as a mouse with track ball 30 and with transducers to determine X and Y movements. With the scanning head plugged in, the unit is used for scanning or if used as a mouse, a third scanning wheel gives the amount and direction travelled which can be used for additional commands in a CAD/CAM program. The scanning head includes a printed circuit board 90, an optical transducer such as a CCD 92, and a light source 98. A third position transducer has an encoder disk 118 for providing distance and direction information. Digitizer puck 22 includes a flux producing element which inductively couples with a plurality of grid conductors in a conventional digitizing pad 24 shown in Figure 2 thereby providing the coordinates of the puck relative to the pad.

While **Jones** shows a multiple use, input, hand-held device, it depends upon electro-optical decoders or electromagnetic flux sensors to provide the inpu information. **Jones** fails to have a scanner for graphic input or to realize that his device has any utility as mouse or drawing pen.

Massoudi, *"Method for Orienting a Dual Mouse Optical Scanner,"* U.S. Patent 4,984,287 (1991), shows the use of a mouse on an orthogonal grid. In Figure 1, scanner 10 is used on a transparent pad 12 which includes a grid pattern 13. The scanner has an array section 24 with a light source 30 and detector 32. Each mouse position sensor has a light source 26 and a detector 28. The detectors are either CCD's or other light sensitive devices. Transparency 12 is transparent to visible light but not to infrared or ultraviolet so that by providing an infrared or ultraviolet light source for the position sensors and visible light for the scanning sensors, the two systems work without interference. The system is put into operation by initializing at an origin location for the dual mouse and then turning the scanner in a circular motion from horizontal to vertical on the grid. The computer remembers the maximum distance, DY, as the space between the two mice.

Massoudi shows optical sensing from a grid pattern using linear CCD's as a detecting device. Figure 2 illustrates the relationship between a canted line of CCD detectors 48 relative to grid pattern 50/54 which is printed, dyed or formed on the surface leaving open blocks 58.

Keiji, *"Input Device Possessing Plural Functions,"* U.S. Patent 5,115,227 (1992) shows an input device which incorporates a plurality of input functions for use with a personal computer. Device 1 can function either as a mouse or scanner with the mode being selected by switch 43. The mouse function is performed with a track ball 2 using orthogonally placed encoders 7 and 8 for sensing the direction of motion. The scanner function is performed using a reading device 20 which is comprised of a light source 28, photoarray diode 26 and encoder 40 for sensing direction and distance. Keiji is dependent upon electromechanical encoders to determine movement, but is relevant for showing both scanning and mouse functions in a single hand-held device.

Montgomery et al., *"Optical Scanner Including Position Sensors,"* U.S. Patent 4,797,544 (1989), shows an optical dual mouse and scanner for use in character recognition, photocopying or other types of applications. Device 14 has one or two optical mice 19, 150, see Figure 7, using as a sensor CCD 16 and light source 21 diagrammatically depicted in Figures 2 and 6. In one embodiment where the device is used to scan text 12 on page 11 of book 10, two colored, lined, transparent sheets are used as indicia of the location. The lines are colored, for example, red for the vertical and green for the horizontal, with the mice having sensors sensitive to these two colors to determine the motion and distance of the scanner in the two directions. In another embodiment, the device and computer is connected to a printer for copying to an optical character recognition unit having algorithms for processing the data in black and white or various shades of gray. Other embodiments of the device call for mechanical scan constraint or ruler, for a screen for scanning a projected image and for arms for use on a drafting table. See for example the depictions of Figures 8a-c and Figure 12.

Knoll et al., *"Process for Picking Up Navigation Data,"* U.S. Patent 4,731,526 (1988) shows a device using a line code lattice and a scanning pen. The lattice has a bar code structure for recognizing the difference between the vertical and horizontal lines. For example, the horizontal line is provided with two thick bars and one thin bar. The vertical bar is distinguished by having two thin bars and one thick bar. The lattice can also be color coded, printed on a map or on a transparent carrier.

Poland, *"Bar Code Reader Configuration and Control Using a Bar Code Menu to Directly Access Memory,"* U.S. Patent 4,825,058 (1989) shows a bar code reader and control system using a menu to invoke instructions or macros which directly access the system memory of the computer, electronic instrument, or a bar code reader. Bar

code reader 11 is operated by entering commands on keyboard 12 or by scanning a menu 15 with scanner 13. Commands entered either by keyboard 12 or scanning pen 13 are used to reconfigure the system by adding or changing codes and their functions. The systems uses an interpreter routine in the operating system of the bar code reader. **Poland** can be used to configure and control not only a bar code reader, but any type of electronic instrument or microprocessor.

Each of these prior art devices use multiple independent means, such as a track ball and scanner, or if only a scanner is used, do not fully function to replace all the input modes of a mouse, scanner, handwriting input, and both a scanning and point-and-click bar code reader. What is needed is a apparatus and methodology which can be inexpensively implemented in which a single linear CCD array can be used for multiple modes of input including scanning, mouse input, handwriting input, and custom and standard bar code reading.

Therefore, an apparatus and methodology is required which is simple in design, small, portable, capable of being hand held, inexpensive and yet powerful enough to be a reliable optical character reader of standard alphanumeric characters printed in conventional materials.

Brief Summary of the Invention

The invention is an apparatus for scanning symbols disposed upon a sheet comprising an electrooptically component for detecting at least a line segment of pixels on the sheet. Another electrooptically component parameterizes the detected line segment of pixels relative to a geometric position on the sheet along a predetermined curve. A housing contains the component for detecting and guides the component for parameterizing along the predetermined curve. The housing is hand held and manually manipulatable for the purpose of scanning the symbols on the sheet. As a result, an inexpensive apparatus is provided for scanning conventional printed materials. In the illustrated embodiment the predetermined curve is a straight line and the symbols disposed on the sheet is a printed line of alphanumeric characters.

The electrooptically component for parameterizing further comprises a ruler defining the straight line. The ruler is manually positioned on the sheet adjacent the printed line of symbols. The housing is arranged and configured to slideably mount on the ruler. The ruler has a longitudinal length and the housing is adapted to slide along the longitudinal length of the ruler over the printed line of symbols, while otherwise being maintained in a predetermined position relative to the printed line of symbols.

The ruler comprises an indicia area defined along the longitudinal length of the ruler. The indicia area provides detectable indicia wherein the geometric position of the line of pixels within the printed line of symbols may be determined.

The indicia area is a plurality of diagonally inclined bars disposed on the ruler having contrasting reflectivity. The bars are diagonally inclined in a direction along the longitudinal length of the ruler.

The electrooptically component for parameterizing comprises a circuit for detecting and measuring movement of the apparatus along the longitudinal length of the ruler relative to the plurality of diagonal bars in the indicia area on the ruler.

The ruler is comprised of a vertical leg and a horizontal foot. The housing is adapted to be guided by the vertical leg. The horizontal foot is adapted to be disposed on the sheet and positioned relative to the printed line of symbols. The ruler further comprises an element for displaying to a user part of the printed line of symbols to be scanned.

The element for displaying the printed line of symbols comprises a component for optically transmitting an image of the printed line of symbols adjacent to the ruler to a predetermined surface defined on the ruler. The printed lines of symbols on the sheet adjacent to the ruler, which are not in a position to be scanned by the apparatus, are obscured from view by the element for displaying.

The apparatus further comprises a circuit for illuminating the symbols on the sheet. The component for detecting comprises an optical device for focusing the symbols on the sheet and a charged coupled detecting device having at least one line of pixel detectors defined therein. The optical device focuses an image of the symbols on the sheet onto the at least one line of pixel detectors in the charge coupled device.

The apparatus further comprises a circuit for isolating a pixel map of at least one symbol scanned by the apparatus from the sheet and a circuit for uniquely correlating a code to the isolated pixel map. Neither the circuit for isolating nor the circuit for uniquely correlating identify the symbol as corresponding to any human readable symbol, but only isolate and correlate the symbol as being a unique graphic pattern according to its attributes and features.

The apparatus further comprises a circuit for establishing a plurality of isolated pixel maps of graphic patterns with uniquely correlated codes from the printed line of symbols scanned from the sheet.

The apparatus further comprises a circuit for scanning a plurality of symbols on the sheet in a sequence as the symbols appear on the sheet and for storing a corresponding sequence of the uniquely correlated codes.

The apparatus further comprises circuit for translating the sequence of codes corresponding to the sequence of symbols on the sheet into a standardized code corresponding at least in part to human readable alphanumeric characters. The standardized codes are ASCII codes for alphanumeric characters and graphic symbols.

The invention is also characterized as a method of scanning symbols on a sheet for input and processing in a computer comprising the steps of imaging at least a line segment from a field of view on the sheet whereon the symbols are disposed. A corresponding plurality of pixels representing the imaged line segment is established. A parameter indicative of the geometric position of the imaged line segment from the sheet is generated. As a result, data derived from the signals may be processed to form bit map images of the symbols from the sheet.

The method further comprises the steps of temporarily storing a plurality of sequences of the pixels ordered according to the parameter signal. The plurality of pixels are grouped to isolate associated pixels corresponding to a unique graphic pattern. An arbitrary number is assigned to the group of pixels of the isolated graphic patterns.

The method further comprises repeating the steps of temporarily storing, grouping and assigning to create in memory a dictionary of unique graphic patterns and unique arbitrary codes assigned thereto.

The method further comprises repeating the steps of imaging, establishing and generating to scan a line of symbols printed on the sheet. Only the arbitrary codes in a sequence corresponding to isolated unique graphic patterns in the line of symbols are stored in a corresponding sequence as the symbols appear in the line of symbols. The step of storing is performed after the dictionary is established for symbols in the line.

The method further comprises the step of translating the sequence of codes into standardized codes of human readable alphanumeric characters and graphic symbols.

The step of generating the parameter signal comprises the step of manually moving a light scanning pen along a ruler disposed adjacent to a line of symbols to be scanned. The light pen reads a plurality of indicia markers on the ruler to provide the parameter signal corresponding to position of the light pen on the ruler relative to the line of symbols on the sheet.

The method further comprises the step of accepting the pixels corresponding to the imaged line only if the light pen is moved into new fields of view along the ruler as determined by generation of the parameter signal indicative of advancement of the light pen into fields of view. Pixels generated as to all previously scanned fields

of view are disregarded. The pixel acceptance is time rate independent so that it is immaterial whether the pixels are scanned at a fast rate or at a slow rate.

The invention is an apparatus for providing input to a computer from an off-screen medium. "Off-screen medium" is defined for the purposes of this specification as any surface other than the computer screen or display on which or from which markings or information may be optically read or written with or without the aid of a machine. In the illustrated embodiment the off-screen medium is a mouse pad or a printed sheet of paper. The apparatus comprises a single linear array of optical detectors, including a related illumination source and optics, and a circuit for selectively configuring the single linear array of CCD detectors in one of a plurality of input modes to optically read information from the off-screen medium. As a result, a universal input device for the computer is provided.

The plurality of input modes comprises at least a static mode input. The static mode input is defined as input through the single linear array of detectors without relative movement of the single linear array with respect to the off-screen medium.

The plurality of input modes also comprises at least one linear dimensional mode. The linear dimensional mode is defined as relative movement of the single linear array of detectors with respect to the off-screen medium in a line of direction.

The plurality of input modes still further comprises at least a two-dimensional input mode. The two-dimensional input mode is defined as relative motion of the single linear array of detectors in at least two nonlinear directions with respect to the off-screen medium.

In one embodiment the off-screen medium comprises a grid. The grid comprises in turn a plurality of horizontal lines and a plurality of diagonal lines. The horizontal lines are detected by the circuit through the single linear array of optical detectors to detect relative motion of the apparatus with respect to the off-screen medium in a direction perpendicular to the horizontal lines. Detection of relative movement with respect to the diagonal lines is interpreted by the circuit to indicate motion of the apparatus parallel to the horizontal lines, so that the apparatus is operable as a mouse input device.

In another embodiment the detectors is packaged in the form of a pen and movement of the single linear array of detectors across the off-screen medium or grid is interpreted by the circuit as a pixel map of handwriting input.

The off-screen medium may also comprise a plurality of unique positions, either denoted by a position relative to a predetermined origin or by an embedded bar code. Each of the positions corresponds to an alphanumeric character or command. The circuit identifies the unique position and generates an ASCII code corresponding to the alphanumeric character or command.

The off-screen medium may include bar codes. The circuit further comprises an activating switch. The single linear array of detectors is disposed across one of the bar codes without movement of the single linear array of detectors across the bar code, and the activating switch is activated to read the bar code upon switch activation . The bar codes may be user-defined or have a predetermined standardized definition.

In another embodiment the bar codes include at least one clock bar. The circuit selectively detects the clock bar to asynchronously time detection of remaining bars in the bar code as the single linear array of detectors are moved thereacross, so that the rate of motion of the single linear array of detectors with respect to the bar codes may be arbitrary.

The off-screen medium may include the grid and a plurality of bar code patterns readable by the apparatus. At least one of the plurality of bar code patterns corresponds to a macro instruction for controlling the computer.

The horizontal lines of the grid comprise a plurality of horizontal lines of a first predetermined thickness and are spaced apart from each other by an distance which when focussed on the linear array of detectors has an image with a length less than the length of the single linear array of detectors. Throughout the specification the optical length of the grid or bar code may be compared interchangeably with the optical length of the linear array depending on what image is actually or imaginarily projected onto the other. The context of the statement will make it clear whether the detector or the detected markings is the reference or physical image and the other the optical image. The plurality of diagonal lines comprise a plurality of diagonal line segments disposed between each of the horizontal lines. The diagonal line segments have a second thickness. The horizontal lines are distinguishable by the circuit from the diagonal lines in part due to their relative thicknesses.

The off-screen medium comprises at least one line of text having at least one character in the line. The apparatus further comprises a ruler for guiding the single linear array of detectors in a predetermined relative position with respect to the line of text. A positioning element positions the single linear array detectors at a predetermined first position relative to a corresponding first character position in the line of text and a predetermined last character position in the line of text. In this way the entire line of text is reliably scanned.

The positioning element is used to dispose the single linear array of detectors to the left of the first character position by a predetermined scan distance and to position the last position of the single linear array of detectors to the right of the last character position by a predetermined scan distance. The circuit for selectively providing input further selectively ignores output from the single linear array of

detectors for the predetermined scanned distances to the left of the first character position and to the right of the last character position to ensure that the entire length of the text line is fully and reliably scanned.

The ruler may further comprise a plurality of positions having bar codes disposed thereon readable by the apparatus.

The invention is also a method of providing a universal input device for a computer comprising the steps of providing a single linear array of detectors, and generating an output from the single linear array of detectors from an off-screen medium over which the detectors are disposed. The output from the single linear array of detectors is selectively interpreted according to one of a plurality of modes. The plurality of modes comprises a static mode wherein the single linear array of detectors and off-screen medium are relatively fixed with respect to each other during generation of the output; a linear mode wherein the single linear array of detectors are moved with respect to the off-screen medium in a single direction during the step of generating the output; and a two-dimensional mode wherein the single linear array of detectors are moved in two noncolinear directions with respect to the off-screen medium during the step of generating the output. As a result, the universal input device is selectively operated as a point-and-click bar code reader, bar code scanner, mouse, handwriting input, and text scanner.

The invention may be better visualized by now turning to the following drawings wherein like elements are referenced by the like numerals.

Brief Description of the Drawings

Figure 1 is a simplified, diagrammatic front cross sectional view of the pen scanner of the invention.

Figure 2 is a simplified, diagrammatic side cross sectional view of the pen scanner of the Figure 1.

Figure 3 is an enlarged diagrammatic depiction of the bar timing scale used in connection with the pen scanner of Figures 1 and 2.

Figure 4 is a graphic depiction of a character showing some of the methods by which the pattern representing the character is uniquely indexed.

Figure 5 is a simplified flow chart of the method through which optical character recognition is achieved.

Figure 6 is a block diagram of a circuit for use in combination with the pen scanner of Figures 1 and 2.

Figure 7 is a simplified flow diagram of the video generator methodology used in the invention.

Figure 8 is a block diagram of the overall CCD pen system of the invention.

Figure 9 is a plan view of the pad or grid upon which the pen is used in order to operate as a drawing board or mouse or in a two dimensional mode.

Figure 10 is a symbolic diagram which illustrates how the line CCD detector is used to detect both horizontal and vertical movement in the grid shown in Figure 9.

Figure 11 is a diagrammatic depiction of a single linear CCD detector of the invention used to read bar code in a click and point mode or zero dimensional mode.

Figure 12 is a diagrammatic depiction of a single linear CCD detector of the invention used to read bar code in a scanning mode or one dimensional mode.

Figure 13 is a symbolic depiction illustrating scanning of a line of text in which the CCD linear detector is positioned at a predetermined distance to the left of the first character at the start of the text line.

Figure 14 is a symbolic depiction illustrating scanning of a line of text in which the CCD linear detector is positioned at a predetermined distance to the right of the last character at the end of the scan line.

The invention and its various embodiments may now be explained in detail in the following detailed description.

Detailed Description of the Preferred Embodiments

A scanning pen is used in combination with a transparent ruler to scan a line of text from conventional printed materials. The scanning pen is adapted to be mounted on and guided along the ruler by the user. As the scanning pen is moved over a line of text, the scanning pen also scans an indicia bar along the length of the ruler to parameterize the pixel data being scanned. In this way, the geometric position of the scanned pixels is independently established from the actual time rate in which the scanning pen is manually moved and independently of whether it is advanced, stopped, or reversed. From the parameterized pixels, pixel maps of the unique graphic patterns corresponding to the symbols are isolated and assigned by the computer or can be assigned by the user a compact code. A dictionary of different symbols is built up for the symbols in the line. Once the dictionary is established, then only the sequence of compact codes is stored. After scanning, a file of the stored sequence of compact codes is then translated through the use of the dictionary by the user to identify human readable alphanumeric characters or symbols corresponding to the pixel map of the unique graphic pattern, if the compact codes are not standardized ASCII codes. In this way, an ASCII file of the scanned alphanumeric characters and symbols is created.

The Pen Design

Figure 1 shows in simplified diagrammatic front cross sectional view a pen scanner, generally denoted by reference numeral 10. The basic components of pen scanner 10 include a housing 12 which is less than one inch in diameter and about 3.5 inch in height, which in gross exterior shape is not unlike a felt tip pen. Housing 12 includes an optical window 14 at its lower end through which light from one or more LED's 16a is transmitted. Light from LED's 16a is focussed through convex cylindrical lenses 17 to a field of view 20 on the opposing side of window 14. LED's 16a in turn are powered by conventional driver circuits 18. In the illustrated embodiment three LED's are utilized in order to provide a full field illumination across optical window 14. Red light of approximately 660 nanometers in wavelength is used although any frequency may be employed including infrared.

Light from LED's 16a is transmitted through optical window 14 to impinge upon the alphanumeric characters or symbols (not shown) which have been printed upon the viewing surface 20. Viewing surface 20 is typically a portion of a book, magazine, newspaper article or other conventional print in printed medium. Light is then reflected from viewing area 20 from the symbols printed on the surface of the page or sheet through optical window 14 up into and along longitudinal optical axis 22 of pen scanner 10. The arrangement and disposition of LED's 16a with respect to the optical path of the reflected light is best depicted in connection with the simplified diagrammatic side cross sectional view of Figures 1 and 2. In the illustrated embodiment three pairs of LED and lens combinations are orthogonally arranged above window 14, two LED's 16a on the sides and one LED 16b on the front. Each LED and lens pair is angled away from optical axis 22 to leave optical axis 22 unobstructed for scanning a central line in field of view 20. LED's 16a are used to illuminate field of view 20. LED 16b and its corresponding lens 17 is focused on side window 32 to illuminate timing strip 46 on ruler 36. LED 16b is coupled to control 18 and controlled separately from LED's 16a. The position and optical parameters of imaging lens 24 in scanner 10 is such that at least one line in the field of view 20 is observable through optical window 14 and is focused on a charge coupled detector (CCD) 26 disposed at the opposing end of optical axis 22. The charge coupled detector in the illustrated embodiment is a conventional 128 pixel by 1 line detector. Many of the types of optical detectors can be substituted for the charge coupled device illustrated including utilizing CCD's having different detector topologies, such as multiple lines or matrices.

Additional pen scanner circuitry 28, such as CCD drivers and clocking circuits as described below, is mounted on appropriate printed circuit boards or other circuit elements within scanner 10.

An optical subsystem of pen scanner 10 comprises a mirror 30 mounted in the lower end of pen scanner 10. Backside surface 34 of pen scanner 10 is arranged and configured to conform a guiding surface of a clear or at least translucent ruler 36. Ruler 36 in the illustrated embodiment has a vertical leg 38 upon which backside surfaces 34 conform to allow pen scanner 10 to be run along the longitudinal length of ruler 36 while keeping the plane of the field of view 20 at a substantially fixed distance from housing 12. In this manner the optical system within pen scanner 10 is maintained in a relatively fixed configuration relative to the plane of the symbols to be imaged. Leg 38 serves as a guide or rail for pen scanner 10. In the illustrated embodiment, ruler 36 also has a horizontal leg 40 which provides for stability of ruler 36 and consequently pen scanner 10 on the surface of the printed sheet. In the illustrated embodiment a straight ruler is used to scan straight lines of text. It is nevertheless included in the invention that a geodesic line or other complex curve could be accommodated if the scanning of a specialized map or projection was needed in which such a complex curve may have particular significance.

In the illustrated embodiment, ruler 36 is clear, polished Plexiglas or hard and transparent plastic. The line of print appearing in the field of view 20 on the paper is clearly visible through the side surface 38 of ruler 36 formed at the top of vertical leg 38. Print underlying ruler 36 in the area 44 along its base may be left visible to allow the user to see the print which is below the line being scanned and can be scanned next, or the surface may be obscured to block the view and allow only the line in the field of view 20 to be seen. Therefore, ruler 36 is positioned on the page such that the line which is desired to be scanned appears clearly through surface 38 just above the junction with leg 40, which typically runs the entire width of the page. The scanned line is thus visible without any obstruction from scanner pen 10 which is positioned above it. With ruler 36 so positioned, pen scanner 10 can be placed upon vertical leg 38 and quickly run along the length of the leg with the absolute assurance that optical window 14 will be appropriately positioned over, above and along the desired line of print as seen through surface 38, which line of print appears on the page within viewing area 20.

The front surface 48 of ruler 36, which is adjacent to rear surface 34 of pen scanner 10 includes a portion 46 which is position juxtaposed to side window 32 of pen scanner 10. Markings, as described below in connection with Figure 3, on ruler 36 in area 46 of surface 48 are visible through window 32, are illuminated by LED 16b, and are reflected by mirror 30 to lens 24 and then to a portion of the linear pixel scanning line of CCD 26.

Pen scanner 10 is manually manipulated or manually slid on ruler 36 by the user. Therefore, the scanning speed of pen scanner 10 across the field of view 20 is

neither necessarily uniform from user-to-user, uniform with any one user, or for that matter, uniform with respect to the scan of a single line. Clearly, pen scanner 10 begins from a stopped position, is accelerated by a user to what can be a variable scan speed, and then manually decelerated to the stop position at the opposing end of the scanned line. Indeed, it is not impossible that the user may also unnecessarily reverse the direction of pen scanner 10 during the scan thereby actually rubbing pen scanner 10 back and forth across the top of ruler 36 as he scans the line.

The diagonal bar coding of Figure 3, which is printed, etched, engraved, pasted or otherwise disposed within area 46 on surface 48 of ruler 36 provides a means by which all of these variables may be accurately compensated. In the illustrated embodiment as shown in Figure 3, area 46 is approximately 0.080 inch in height and runs the longitudinal length of ruler 36 parallel to the scanned line in field of view 20. Area 46 is provided with a plurality of diagonal black or at least nonreflective bar segments 50, which in the illustrated embodiment each have a width along the horizontal direction of Figure 3 of approximately 0.010 inch. Each diagonal bar 50 in turn is separated by a blank space or at least a space of contrasting reflectivity for approximately 0.030 inch of length in the horizontal direction of Figure 3. In the preferred embodiment the reflective area is a white surface. The reflected light from LED 16b is reflected from the reflective portions of surface 46 to mirror 30 to establish a brightness level. The degree of reflection from the reflective areas on surface 46 and its contrast with the diagonal nonreflective bars is known so that a standard illumination level can be established by LED 16b and surface 46. Contrast measured between dark and light areas in the scanned field of view can also be determined and compared to the standard from LED 16b. The power then supplied to LED's 16a, which are separately controlled from LED 16b, can be increased or decreased to match the standard established by LED 16b. The reflected standard brightness level is thus used to adjust the driving intensity of LEDs 16a.

Light from bar area 46 is focused back through the optical system of pen scanner 10 onto CCD 26, which is diagrammatically and symbolically depicted as being the scanned portion shown by segmented line 52 in Figure 3. The length 54 of line 52 can be thought of as being 32 pixels long as measured by the number of detecting cells in CCD 26 which receive light focused from area 46. Of these 32 pixels, only 16 along the length 56 of line 52 are used to generate necessary timing signals to indicate the geometric position of scanning pen scanner 10 along the longitudinal length of ruler 36 and hence the line to be scanned within viewing area 20. A lower portion 58 of eight pixels are ignored to interface between two scanned lines. Similarly, eight pixels along the top portion 60 of line 52 are not used for detecting diagonal timing bars 50. Instead, an upper portion 62 corresponding to the

top four pixels of line 52 is placed over a completely black bar 62 which runs along the longitudinal length of area 46 on ruler 36. Black bar 62 is used for a height reference or vertical position calibration of pen scanner 10 with respect to area 46 as depicted in Figure 3.

Therefore, only the pixels within portion 56 of line 52 are used to detect diagonal bars 50. As the detector line 52 moves to the right, for example, in Figure 3, a lowermost detector cell 64 will detect bar 50. As line 52 continues to move to the right, the next detector cell 66 up will detect the black diagonal bar. The triggered detecting cells continue to move upward along portion 56 of line 52 as long as detector line 52 moves to the right. As soon as the first pixel or cell 68 out of the measurement zone of portion 56 goes active, the lowermost cell or pixel 64 will again become active because it is now placed over the next adjacent diagonal bar 50. Therefore, regardless of the position of detector line 52 along area 46, at least one of the detector cells within area 56 will detect the presence of diagonal bar 50. The cyclic detection of detector cells within portion 56 of detector line 52 is then used as a characterizing variable or parameter in combination with optical information detected by the remaining portion of CCD 26 focused upon viewing area 20.

In this way, a parameterized data flow of the observed images in field of view 20 is created which is totally independent of the rate at which parameterizing variable is generated. If the user should inadvertently backtrack, the direction of detecting cells within portion 56 of line 52 will reverse and these parameterized values can then be deleted or blocked so that it only freshly scanned pixel areas in the field of view 20 will be processed or stored. Similarly, if pen scanner 10 should be brought to a stop during the middle of a scan line, the generation of parameterized values will also stop. Data corresponding to the observed field of view will be generated only when new geometric areas within the field of view 20 are scanned regardless of the arbitrary or random nature of motion of pen scanner 10 along ruler 36. The graphic resolution of the scan is then in part determined by the number of pixels or scan cells within scanning portion 56. For example, sixteen pixels are horizontally placed in the space of 0.040 inch yielding a resolution quality of 400 dots per inch.

Isolating and Identifying Character Patterns

Before considering the circuitry with is used in combination with scanner pen 10, consider first the methodology by which a character is optically read. In the illustrated embodiment, portion 70 of the field of view 20, which is diagrammatically depicted in Figure 4 and corresponds to a single character, is conceptualized as divided into a plurality of spots 72 such as is depicted in Figure 4 in field of view 70. Therefore, if any of these spots 72 have a black pixel corresponding to the character

in it, that fact then serves to characterize the pattern or shape of the character. In Figure 4 eight spots 72 are shown by way of example and comprise a first type of index to type the pattern.

Similarly, in addition to the eight spots 72 shown in Figure 4, there are six bars which characterize the character's field, three vertical bars 74 and three horizontal bars 76. Below the base line 78, indicated as a dotted line in Figure 4, there may be depending portions of the character which occur in a lowermost horizontal bar 80 as well as one or more of the vertical bars 74. Again, whether or not there is any pixels or portion of the character within these bars provides six additional indices of a second type by which the pattern of the character may be identified.

Still further, in addition to whether certain spots or bars contain parts of the character, the number of white-to-black and black-to-white transitions as one moves along vertical bar 74 or horizontal bar 76, or line within the bars, can also be identified from the pixel pattern to provide further characterizing indicia of a third type. Any or all of these or any combination of these or any other system for indicia coding a two dimensional area, which is now known or later discovered, may be employed in combination with the present invention.

Therefore, it can be understood that what is produced is a parameterized set of pixels, which are parameterized in the field of view 20 by a position parameter derived from the diagonal bar code from area 46 of ruler 36, with a corresponding set of parameterized derived indicia of the pixel map. Real time is not used as a parameterizing variable and is therefore irrelevant to the data input and reduction. As each vertical line of pixels is produced in parallel as the scan line moves from left to right across each character's field of view 70, a parameterized pixel map of the entire line is generated. Software processing of the parameterized pixel map is performed on a real time basis to generate indicia identifying if any of the pixels fall within designated areas 72-82 and, further if necessary, the number of black-to-white and white-to-black transitions along any line or direction in field of view 70.

As described below the pixel map or indicia are grouped to isolate each separate pattern, the pattern classified to form a dictionary or to compare to an existing dictionary. By what ever means is chosen according to the selected rules, a plurality of indicia are collected which uniquely identify a pattern. As this pattern recurs, the same set of indicia will be generated.

In one embodiment of the invention, the sets of indicia, identifying the alphanumeric character or symbol are then arbitrarily assigned a binary code. This embodiment may be desired where scanning occurs at high speed or without an on-line connection to a computer for performing translations of raw OCR data to ASCII data. This would be used, for example, where the data was temporarily stored in a

floppy disk drive and later transported to a computer where the raw output of the text was edited and corrected. In any application where large amounts of text had to be temporarily stored for any reason before display and editing, an intermediate arbitrary code assignment would be beneficial.

What is stored is not the indicia which are generated on a real time basis, but a single code which may only be a few binary bits. For example, four bits representing the numbers 0 through 31 are required to store the 26 letters of the Roman alphabet and 10 numerals. The uniquely identified patterns, which are not yet associated with any human readable symbol, are only known by an arbitrary code. The arbitrary code, which may be as small as 4 bits, is stored in sequence and the corresponding pixel maps or indicia groupings discarded except for a dictionary which has been built up as part of the scan.

Later, a translation is made with the help of human interpretation between the unique arbitrary codes corresponding to the pixel maps of the symbols in the dictionary and standardized ASCII codes.

No storage in the indicia or the pixel map is made or attempted. Only the sequence of arbitrarily assigned codes are stored. The speed in which the indicia is collected and codes uniquely correlated to the distinguishable sets of indicia is done on a real time basis. At the present time the maximum speed of scan is approximately 6 inches per second, but can be increased by ordinary hardware or software modifications known or to be expected in the art.

Only one pixel map for each code is stored. Therefore, each of the codes corresponding to a pixel map together with a serial file of the codes are stored in a conventional manner into a personal computer. Under appropriate software control, the human operator then displays each uniquely identified pixel map and assigns an ASCII code corresponding to it relating the standard alphanumeric, upper or lower case symbol. An association is then made under software control within the computer between the human identified ASCII character and the arbitrarily assigned binary code. The serial file of binary codes is thereafter translated at high speed through conventional software techniques in the personal computer into a corresponding series of ASCII codes to create an ASCII which can be displayed and, which when displayed, is human readable. The translated ASCII file is thus in a form which is directly readable by conventional word processing or other application software.

What has been described above is particularly adapted to a system where partial OCR processing occurs outside of the personal computer where the final ASCII text is assembled. Alternatively, the indicia and features of each character are directly associated by the user with an ASCII code without the generation of an intermediate arbitrary code. The pixel map of the character is displayed and the user

presses the corresponding key on a conventional computer keyboard to assign the related ASCII code number to the collection of indicia as described in connection with the methodology of Figure 5.

Methodology of Character Reading

The methodology by which the optical character reading process occurs is summarized in the flow chart of Figure 5. The flow chart begins at step 82 with the input of a line of image data. This line in the illustrated embodiment comprises a 96 by 1 pixel scan from device 26 for each horizontal increment. Entire line of text is in this way sequentially assembled in step 84. The data representing the line is compressed at step 86 and can in one embodiment be stored on a stand alone floppy at step 88 or transferred via an RS232 serial port at step 90 to a conventional personal computer. Alternatively, the scanned image can be transferred to the personal computer via the parallel port or computer bus at step 92 directly following its line assembly at step 84. Each of the steps 82-92, above the dotted line in Figure 5, are performed in the pen or its associated circuitry. The remaining steps described below are performed in the illustrated embodiment in the personal computer. However, it is to be expressly understood that the allocation of processing burden between the personal computer and pen circuitry can be altered from that described consistent with the teachings of the disclosure.

The pixel data can then be read into the computer from the stand-alone floppy or memory device at step 94 or transferred on the serial port from step 90, and stored in the random access memory in the computer in compressed form at step 96. In either case, the pixel data is then expanded at step 98. The text line is then processed at step 100 by detecting the white spaces between each character to isolate each character field of view 70 as shown in Figure 4. Parallel input in noncompressed form is stored in the memory at step 102 and is directly followed by text line processing at step 100. If the type height is such that more than one line is scanned in the 96 pixel active line, the limiting top and bottom white spaces are also identified and the portions of partly scanned upper or lower lines are disregarded, leaving the desired center line only for further processing. Correction for small amounts of line skew are also made in case the ruler has been inappropriately placed on the printed sheet. Excessive skew is detected and an error signal generated alerting the user to align the ruler correctly with the line to be scanned. Only data corresponding to a properly aligned scan is accepted for further processing. If there are no further characters in the line being processed, then a determination is made whether or not there is any more input data, such as might be held in a buffer in combination with a time-out

signal, or which may be arbitrarily determined by the user by closing switch 112 on pen scanner 10.

The refined pixel data is then restored in memory at step 200 and/or may be stored in a floppy disk or hard disk at step 201. At this point the pixel data may be displayed virtually on a real time basis in an LCD display in the pen circuit 138 at step 202 or on an output screen in the computer at step 206. The speed of the methodology of Figure 5 is such that all of the steps discussed thus far are performed at a rate which allows the refined pixel image of the scanned line to appear on a display by the time the user has finished scanning the line with the pen.

At this point optical character processing begins with step 204. The geometric indicia of each character is also identified in step 204. These indicia are grouped into a predefined format for purposes of fast and efficient indicia comparisons. A dictionary or table is then established by storing each pattern and its indicia of features at step 208. An ASCII code will be assigned to the isolated and type pattern and/or group of indicia as described below.

The data is now loaded into a user screen editor at step 206. An inquiry is then made in the screen editor 206 to allow the user to assign the ASCII code to each character for each line for the refined pixel map displayed from step 200. As the line of characters are assigned ASCII codes, an ASCII code dictionary is built up in step 208 correlating character features and attributes to ASCII codes.

Once a character dictionary begins to be built the OCR process will assign ASCII codes to as many pixel patterns it recognizes and assemble a raw ASCII file at step 210. The remaining characters of the font will be filled in or any errors in th OCR process will be subject to user correction on the screen editor. A conventional line-by-line spell checker 212 is used to speed identification and correction of errors in ASCII assignments. Manual corrections are always permitted. Ultimately a corrected ASCII text file is created at step 214.

There are a variety of which in which the scanned lines may be displayed and processed into an ASCII text file. The preferred ones will be now described. As described above, it is possible to simply display the refined pixel map or image of each line on the screen on a real time basis without any OCR processing. It is also possible to display and process the scanned lines, including spell checking, on a line-by-line basis either immediately after it is scanned or at a later time from an external memory from step 94 or from an internal memory from step 201. Finally, batch processing and spell checking is also possible from a raw ASCII batch file created in OCR processing step 204 once the font dictionary has been built.

Hardware

Turn now and consider the hardware system as diagrammatically depicted in the block diagram of Figure 6. Pen scanner 10 of Figures 1 and 2 is coupled to a main electronics assembly, generally denoted by reference numeral 104. The main electronics assembly 104 is then coupled through an RS232 cable 106 to serial input port 108 of a conventional personal computer. The main electronics assembly 104 and pen scanner assembly 10 are powered by a power supply 110. In the illustrated embodiment assembly 104 and supply 110 are housed in separate packages from pen scanner 10.

Turn now and consider the electronic components within pen scanner 10. Pen scanner 10 includes a plurality of LED's 16a and b as described above. In addition, there is a push button switch 112 which allows the user to provide a manual command signal to start and stop the scanning operation. CCD 26 in turn is driven by conventional CCD clock drivers 114. Pen scanner 10 is then coupled through a pen cable 116 to main electronics assembly 104.

CCD driver circuit 114 is the interface between the digital electronics of main electronics assembly 104 and CCD 26. In the illustrated embodiment, CCD 26 is a Toshiba TCD 104D device using MOS technology in non-TTL driving signals. Because of the high capacitance of the inputs to CCD 20, clock drivers 124 are required to provide sufficient current to drive at the required input voltages. Clock drivers 114 are also located within pen scanner 10 to avoid ringing.

The video data from the 128-by-1 pixel CCD 26 is received by a threshold detection circuit 118 which provides for signal conditioning and shaping to convert the pixel signals from CCD 26 to appropriate levels as digital data. The video data is then assembled in parallel format in a serial-to-parallel to converter 120. The words of data are then clocked onto a data bus 122, stored within a 64K x 8 random access memory, (SRAM) 124. A central processing unit (CPU) 126 is also coupled to data bus 122 and determines whether or not the data being stored in SRAM 124 is good data corresponding to fresh pixel fields scanned under pen scanner 10 as described below.

CPU 126 provides the brightness control of LED's 16a and b through control line 138. The LED's are maintained at a illumination level to provide sufficient contrast between dark and white areas in the CCD output. CPU 126 is also operative to control circuitry to turn LED's 16a and b on and off.

SRAM 124 is addressed through an address counter 128 which is also controlled by CPU 126. The program for controlling CPU 126 according to the teachings of the invention is contained within a read-only memory, (EPROM) 130 connected to CPU 126. In the illustrated embodiment, ROM 130, CPU 126 and the RS232C converter are included as part of a single board or single chip

microcontroller. In the illustrated embodiment, the single board microcontroller is based upon an 8031 Intel CPU executing software stored in 32K by 8 EPROM 130. The microcontroller board contains not only RS232C converter 132, but address decoding and all other functions required for stand-alone operation for the Intel 8031 microcontroller. The contents of SRAM 124 are read through the I/O interface of the microcontroller.

Threshold detector circuit 118 converts the video output of the CCD 26 into digital signals to be used by the video capture circuitry. The video output of CCD 26 is an analog signal which indicates the intensity of each pixel that the CCD is imaging. In optical character recognition application, gray scales are unimportant. Therefore, it is only necessary to know whether the pixel is black or white. The final output of threshold detection circuit 118 is therefore a logical one for black and a logical zero for white.

Serial-to-parallel converter 120 acts as a video capture circuit to store the output of threshold detection circuit and SRAM 124. In the illustrated embodiment, SRAM 124 is in reality comprised of two 32K by 8 SRAM devices, three counters and is combined with serial-to-parallel converter 120. Upon the receipt of every 8 pixels, a byte is stored from converter 120 into SRAM 124. The address of SRAM 124 is incremented in time. After 16 bytes or 128 pixels have been stored in SRAM 124, an interrupt is sent to CPU 126 so that SRAM encoding data can be examined.

If the encoding data indicates the pen scanner has not moved sufficiently to be recognized as new fresh pixel input, the data will not be saved and address counters 128 for SRAM 124 will be decremented by 16 counts. The next line of video information will then be overwritten the previous data.

When the user releases the push button switch 112 or when sufficient data of a predetermined amount, such as 2400 scan lines, which is equivalent to six inches of print, has been input, CPU 126 will transmit the data via an RS232C converter 132 to serial port 108 of the personal computer. The scan length of six inches is a design option of the illustrated embodiment, and there is no limitation in the underlying design to extend the scan length even farther. If for any reason an error should be detected in the data input, and error LED 132 is activated thereby signaling the user to rescan the line. Error LED 132 is lit whenever some type of fatal error has occurred in the hardware. Typically, LED 132 will be lit when scanning occurs at too fast a rate or there are data transmission errors.

CPU 126 is also coupled to timing circuitry 134. Timing circuit 134 is driven by an 8 MHz oscillator 136. Timing circuit 134 is coupled through cable 116 to CCD clock driver 114. The signal received by timing circuit 134 from CPU 126 is an image integration time which defines the length of exposure that CCD 26 is exposed to the

image. Too short an integration time will not provide sufficient image contrast. Too long an integration time will cause a reduction in resolution because individual pixels will saturate and spill into adjacent pixels. In the illustrated embodiment, the integration time is specified to allow the scanning of 2400 lines of image in one second. This integration time turns out to be approximately 417 microseconds. The integration time is adjustable through software modification.

Timing circuit 134 generates the proper timing signals required for CCD device 26 each time that an exposure clock is received from CPU 126. All timing signals are created in programmed array logic devices by clocking down the output of 8 MHz oscillator 120. The CCD timing signals provided are TTL compatible and are converted to MOS levels for coupling to CCD 26 by clock drivers 114 in pen scanner 10. Additionally, timing circuit 134 creates other timing signals that are used to control the circuitry that capture the scanned data.

RS232C interface 132 is capable of transmitting data at 57,600 bits per second. The transmission clock is in internally generated within CPU 126. Theoretical transmission rates may be limited by noise on cable 106 or by limitations in the ability of CPU 126 to read data from SRAM 124 at high enough speeds.

Scanning pen 10 is capable of capturing video data from CCD 26 at burst data rates of up to 2 MHz. Each individual line of 128 pixels of video data will be stored in SRAM 124 at this rate. Since 16 pixels are sent out from CCD 26 as described in connection with Figure 3 prior to generation of the actual image data, approximately 75 microseconds are required to store all the data. However, a longer time, namely 417 microseconds, is required for the integration time or exposure time within CCD 26. During the time between scanned lines, CPU 126 examines the encoded information in the first 32 bits of video data to determine whether the imaging area has moved by at least 1/400 of an inch. If not, the pen scanner will be considered as stopped.

The RS232C data transfer rate determines the time period required to send 2400 scan lines of 96 image bits to the personal computer. The transfer of image data to the personal computer occurs in less than one second. Therefore, 230,400 bits are transmitted in less than one second. To achieve this, CPU 126 compresses the data by more than 4-to-1 to maintain continuous data transmission. The CPU processing rate is set to enable it to receive the stored at this rate and to further provide additional transmission time for error detection and retransmission.

Software/Firmware

The software for pen scanner 10 is made up of two distinct programs, namely the personal computer application software and the pen scanner control firmware.

The personal computer application software receives data across the RS232C interface and decompresses it and then performs the optical character recognition (OCR) algorithms such as those described above. The pen scanner control firmware actually controls pen scanner 10 hardware as it captures data from CCD 26. After the user initiates the scanning process, the firmware sends the scanned data to the personal computer application software through the RS232C interface.

Figure 7 is a simplified flow diagram of the pen scanner control firmware. The following power-on at step 140 initialization module 142 is activated to initialize both the pen scanner hardware and CPU firmware. This task includes initialization of interrupts, setting of interrupt vectors, zeroing of memory, initialization of global variables and the like in step 144 followed by disablement of clocks and illumination activation of the LED's at step 146.

A firmware standby module 148 is then entered which is executed when the user is not operating pen scanner 10. The function of standby module 148 is to wait for the user to press the scan button 112 to indicate the scanning process is to begin. When button 112 is pressed, program execution jumps to the data capture module 150.

Data capture module 150 sets up the control hardware to receive the stored data from CCD 26. Module 150 begins by setting a timer interrupt of 416 microseconds. The timer is the integration time or exposure time of CCD 26. Each time the timer interrupt occurs, the firmware sends an interrupt signal requesting one line of scanned data from CCD 26. The hardware stores the data and sets the scan interrupt signal low. The firmware waits for the scan interrupt low signal while monitoring the scan button. If the scan button is released before the next scan line is loaded, firmware execution jumps to the transmission module 162. Otherwise execution jumps to encoding detection module 164. While in the data capture module 150, counters are cleared and the LED's enabled at step 154, the exposure timer is set up to 460 microseconds at step 156, and the scan interrupt is initialized at step 158. Monitoring of the status of button 116 is made at step 160.

Encoding detection module 164 determines whether pen scanner 10 has moved sufficiently to require saving the current line of CCD data. The software examines the top 16 bits of data from the current CCD line at step 166 and compares the 16 bits of data from the previous line at step 168. If the encoding data has not changed, the software waits for the next line of CCD data by returning to step 160 in data capture module 150. If the encoding data has been incremented by one bit, the hardware line counter is incremented at step 170. If the encoding data shifts by more than 1 bit indicating the horizontal advance of the scan by more than one pixel, an error light is lit at step 172 in error handler module 174. The LED's and CCD clocks

are then disabled at step 176 and the systems waits for the release of button 112 at step 178 after which it returns to standby module 152.

Coding detection module 164 keeps track of the number of data lines which have been saved in SRAM 124 at step 180. If 2400 lines or six inches or more of scan have been saved, the scanning process is ended and firmware execution jumps to transmission module 162. Transmission module 162 reads through the entire scanned memory space and transmits the image data to the personal computer over the RS232C interface. It does this through disabling the LED and CCD clocks at step 182 and clearing the counters at step 184. The SRAM is set up for reading at step 186 after which the timing or encoding line of bytes (32 pixels) is read and discarded at step 188 and the bytes of valid image data (96 pixels) read at step 190. The explicit parameterization of the pixels to horizontal position may be dropped from the data flow at the point when it is determined that each line of the image pixel data is fresh or nonrepeated. The sequence of pixel lines as stored is then relied upon for relative scanning order. The data is compressed by compression module 192 and then transmitted at step 194. The transmission continues in a cyclic pattern until 2400 lines are transmitted as determined at step 196.

In addition to determining when the user has scanned the line too quickly, error handler module 174 is also entered when there is a serial communication error when transferring data to the personal computer or when the user has scanned more data than six inches or 2400 lines.

The advantages of the invention can now be appreciated. These advantageous features include the following.

The ruler allows the scan line to begin at the very end of the ruler so that there are no or at least very small unscannable margins as often occur in prior art scanners. The line to be scanned is visible through the ruler and when so seen the ruler is positioned exactly in the correct position to scan the line. The text line being scanned is visible to the user through the ruler as it is being scanned which is a feature not realized by prior art scanners. The ruler allows even the user with the most unsteady hand to make perfect mechanical scans and to avoid scan errors. The ruler also keeps the scanned sheet flat, thereby removing imaging errors introduced by other types of scanning technique.

The text and timing bar codes are scanned with the same pixel resolution. The black and white scanning technique allows the graphic resolution or image control to be substantially increased over that which is common to color scanners. A single CCD device is used for two functions, namely scanning the text pixels and timing.

The user can select just one line or a portion of one line to be scanned into the computer. This allows unnecessary text to be ignored and not to even be input or

processed, which is not possible with full page scanners. This not only substantially decreases processing time but decreases editing time and effort. It also allows a system to be provided which utilizes less memory and processing power than is required for page scanners doing the same job.

The scanning mechanism does not include any complex electromechanical parts or moving parts as is necessary for page scanners, yet is capable of achieving long scan line lengths at high resolution values. The scan head does not touch the scanned material leaving the scan head in a cleaner and more unworn condition than scanners which require contact.

The invention is a universal input device for a computer which can be either used as a point-and-click bar code reader, a bar code scanner, mouse, handwriting input, or text scanner. The universal input device can be used to read both arbitrary user-defined bar code or standardized bar code. In either case, the bar code may symbolize any alphanumeric character, command or macro instruction for an operating system which is programmed on the computer. The universal input device uses a single line of linear CCD detectors. In the static mode, the single linear array is used as a point-and-click input device for bar code, provided that the optical length of the bar code is equal to or less than the length of the single linear array. The optical length of the bar code is defined as the length of the bar code image as it is focussed on the linear array. The length of the bar code itself is the distance between the first and last bars in the collection of bars comprising the bar code. In the linear mode, the optical length of the bar code may exceed the length of the single linear array and the array is then moved or scanned over the bar code so that the directioı of the linear array is colinear with the length of the bar code. In the two-dimensional mode, a grid is used in combination with the single linear array to detect vertical and horizontal motion of the array. Alternatively, a scanning ruler with diagonal timinr bars may be used to guide the array across the line of text which then processed for character recognition. Still further, the array can be used in the two-dimensional mode to provide a bit map of handwriting. Used to read bar codes or as a mouse, the input device can be used to simulate an ASCII keyboard to input ASCII codes corresponding to the alphanumeric characters.

Figure 8 is a block diagram which illustrates a system devised according to the teachings of the invention. A pen 210 or other hand-held apparatus, which includes a single linear CCD array, is coupled as an input device to a PC interface card 212. PC interface card 212 conditions and formats the signals output from pen 210 so that they are intelligibly communicated to a conventional computer or more particularly a conventional personal computer operating system 214, such as the data and control bus. Computer system 214 is provided with software that allows the system of Figure

8 to be operated according to user selection as a text scanning module, a mouse module, a handwriting input module, a custom bar code module or a standard bar code module. Software modules corresponding to these modes of operation are symbolically illustrated in Figure 8 as text scan module 216, mouse module 218, handwriting input module 220, custom bar code module 222, and standard bar code module 224. In the preferred embodiment, modules 216-224 are software modules stored within a conventional computer systems hard disk memory, random access memory card, or in nonvolatile read-only memories.

The system operates through text scan module 216 to operate as a scanning optical character reader, or pixel scanner with program features which include display, editing, storage and graphic PCX or other formats and form later retrieval and optical character recognition (OCR).

The system of Figure 8 when operated as a mouse module 218 is capable of performing as a high resolution, 400 dot per inch, or low resolution, 200 dot per inch, mouse or drawing pencil with adjustable speed and distance parameters equivalent to such adjustments as are provided for conventional light pens.

The system of Figure 8 is also capable of operating as a handwriting input module 220 of high 400 dot per inch resolution or low 200 dot per inch resolution, again in the combination with a grid pad described in greater detail in connection with Figure 9. When so operated system 214 with pen 210 is capable of inputting signatures or other handwriting for storage in graphic PCX or other formats.

The input device in the system of Figure 8 can also be used as a bar code reader by means of a custom bar code module 222, which includes the capability of printing user defined bar codes. The user defined bar codes can be used as function keys or optically read macros of any application's program loaded within the computer system of Figure 8, which bar codes can also be mounted on the periphery of and read from the grid pad of Figure 9.

In addition to reading custom bar codes, the system of Figure 8 operates as a standard bar code module to read in bar codes having standardized formats in such a manner that the scan is speed independent. As a custom or standardized bar code reader pen 210 and system 214 in combination may be used statically to point-and-click the entire bar code in or may be scanned across the bar code.

These functions can be considered as operating in three modes. First, there is the static mode or what might be termed a zero dimensional mode in which pen 210 is statically placed over a region of printed bar code without movement. The bar code is read or scanned while pen 210 remains stationary. Operation in this mode is referred to as "point-and-click."

A second mode of operation is defined as a one dimensional operation or linear scanning. In this mode, pen 210 is moved by hand along a line, which preferably is a straight line, but need not be. In this mode, pen 210 operates as a scanner.

The third mode of operation is described as a two dimensional mode in which pen 210 is used in connection with a grid shown in Figure 9 as a mouse, bit map input device such as for handwriting input.

Turn now to Figure 9 wherein pad 226 is diagrammatically illustrated in top plan view. Pad 226 includes a central portion comprising a grid 228 surrounded by a plurality of bar code areas 230. Some of the areas 230 may be provided with standardized bar codes which are permanently provided or others may provide for customized bar codes generated by the system of Figure 8 in response to interactive user input and which can be temporarily inserted into or onto pad 226.

Grid 228 is a two-dimensional area, preferably a rectangular area in which a plurality of thick horizontal lines 232 and interlying diagonal lines 2234 have been provided. The thicker horizontal lines 232 extend across the entire width of grid 228. The shorter and thinner diagonal lines 2234 are placed in the spaces between horizontal lines 232 and extend only part way across the distance separating adjacent horizontal lines 232.

Turn now to Figure 10 which is a symbolic diagram in enlarged scale of a small portion of grid 228 of Figure 9. Figure 10 depicts portions of two adjacent horizontal lines 232 with three interlying diagonal lines 234a, b and c therebetween. In the illustrated embodiment, diagonal lines 234a, b, and c are inclined at an angle of approximately 45 degrees. Lines 234a, b and c and 232 are printed in contrasting color on a substrate such as heavy paper, which may be included within a laminated or lose flat plasticized envelope constituting part of grid pad 226.

Line 236 in Figure 10 symbolizes a single linear array of charge coupled detector (CCD) elements included within pen 210. Assume that array 236 is aligned vertically across grid 228 so that single linear array 236 is perpendicular to horizontal lines 232 and crosses diagonal segments 234a at an angle of approximately 45 degrees. An upper group 238 of the detector elements of array 236 will detect the upper bar 232 while a lower group 240 of detectors detect the adjacent lower bar 232b in Figure 10. At some point in the middle of line array 236 between group 238 and group 240, a group 242 will detect horizontal segment 234a. The number of pixels detected by groups 238 and 240 will be equal and each be greater in number than the number of pixels detected by group 242 since horizontal bars 232 are thicker than diagonal segments 234a, b, and c even when increased for a diagonal section. The number of the detected pixels from groups 238 and 240 will identify the pixels

detected by group 242 as the pixel group measuring or corresponding to one of the diagonal lines 234a, b or c.

If single linear array 236 moves vertically in Figure 10, the number of pixels detected by groups 238, 240 and 242 will remain substantially constant. However, the position of the detectors on single linear array 236 for which a pixel is detected will change equally for each of the groups 238-242. Therefore, if single linear array 236 has a 400 dot per inch pixel resolution, a change of the position of any one of the groups 238-242 on single linear array 236 by 240 detector positions will be measured as one tenth inch displacement of pen 210 in the vertical direction.

If, however, single linear array 236 moves horizontally or to the right in Figure 10, the number and location of pixels in group 238 and 240 remain constant. The number of pixels in group 242 also remain substantially constant but the location of these pixels will move upward in the diagram of Figure 10. Since diagonal segments 234a, b and c are at a 45 degree angle, the movement of one detected pixel upward in group 242 indicates a horizontal movement equal to the resolution limit of one pixel, which in this example is one four hundredth of an inch.

As pen 210 continues to move horizontally or to the right in Figure 10, a line at position 244 will ultimately be reached in which single linear array 236 spans two adjacent diagonal segments 234a and 234b. Two groups functionally equivalent to group 242 will then be provided between groups 238 and 240. This serves as a trigger signal to indicate to computer 214 that single linear array 236 is straddling two adjacent diagonal bars 234a and 234b. As soon as full overlap is lost from diagonal bar 234a, internal software counters must be reset in the position of the lower pixel group, which now lies over diagonal bar 234b, which is monitored to further track horizontal movement. Movement to the left of Figure 10 is of course handling in just the reverse manner. In any case, total horizontal movement relative to a start position can be measured in absolute terms.

Alternatively, the relative separation or pixel distance between either group 238 and group 242, or between group 240 and 242 may be monitored to determine when the end of line 234a is reached and counters reset to remeasure horizontal movement relative to the distance between these two groups as read from the adjacent line 234b.

Movement of pen 210 simultaneously in the horizontal and vertical directions on grid 228 produces the two independent output patterns from single linear array 236, namely simultaneous and equal changes in the position of the detecting groups 238-242 on single linear array 236 for vertical movement and relative movement of group 242 with respect to groups 238 and/or 240 for horizontal movement.

In the description above and in Figure 10, single linear array 236 has been shown in the vertical orientation for the sake of simplicity of understanding and illustration. What is depicted is not necessarily the relative physical size of the linear array, but the optical projection of the linear array onto the grid through the optics used in the device. If single linear array 236 were inclined at an arbitrary angle with respect to lines 232 and 234a, b and c, the analysis would not be materially changed. The only difference caused by inclination of single linear array 236 with respect to lines 232 and 2234 of grid 228 is that the intercept length of groups 238-242 across lines 232 and 234a, b, and c are increased. The amount of increase is strictly geometrically related to the degree of inclination and is uniform for each of the groups 238-242. Any variation in the intercept length, can thus be easily accommodated or even ignored without changing the analysis whereby horizontal and vertical movement are detected as described above. It is both the absolute and relative relationship between the positions of groups 238-242 on single linear array 236 that indicate vertical or horizontal movement and not how many pixels are detected by each group.

Consider now the various modes of operation beginning with the zero dimensional or static mode. The static mode, used as a static bar code reader, is the simplest of all modes in which CCD single linear array 236 is placed over a bar code pattern 246 as diagrammatically depicted in enlarged view in Figure 11. A switch included on pen 210 (not shown) is then manually depressed to point-and-click single linear array 236 over bar code 246. The number, width, or both of the bars comprising bar code pattern 246 are then detected by the various detectors on single linear array 236. Linear array 236 is held stationary and all the pixel detecting cells within single linear array 236 are electronically scanned to provide a sequential series of input bits. In effect, a bit map of a slice of bar code pattern 246 is obtained and this bit map can then be read either using user-defined custom bit code formats or adopting standardized bit code formats, according to conventional software control by either custom bar code module 222 or standard bar code module 224 within the system of Figure 8.

Consider now the first dimensional or linear direction mode. Single linear array 236 is symbolically shown in Figure 12 in enlarged scale as being manually drawn or moved across a bar code pattern 248. A first bar 250 in pattern 248 is a clock bar which provides a timing signal through single linear array 236. The rate of change at which the bar code creates a signal propagating down single linear array 236 is a direct measurement of the speed of manual scanning of array 236 and is used for asynchronous scan timing during the entire scan. Therefore, when single linear array 236 reaches the remaining bars 252 in bar code pattern 248, the width of bar

code 252 is measured according to the pixels which are clocked or strobed as single linear array 236 is scanned over pattern 248 as driven by a clock signal triggered by clock bar 250. Therefore, even an arbitrarily moved scan will nevertheless accurately scan or measure the width of bar 252.

The need to switch from the old clock bar to a new clock bar is triggered by tracking the clock bar as it moves down single linear array 236. When this tracked clock bar reaches the last position in single linear array 236, the next detection at the beginning pixel of the single linear array will then be treated and tracked as the new clock bar. Only pixel detections to the right of the clock bar pixel will be used so that when a new clock bar pixel is reset at the beginning or right end of single linear array 236 in Figure 12, pixel detections to the left of it, which have already been detected with respect to the old and prior clock bar, but will still be under the line of scan of single linear array 236, will be ignored. Only new detections which occur in single linear array 236 to the right of the new clock pixel will be acknowledged.

Clearly, accurate clocking occurs only so long as clock bar 250 remains under the line of scan of single linear array 236. For this reason, bar code pattern 248 periodically includes clock bars 250 at intervals which do not exceed the length of single linear array 236, which is typically approximately 0.2320 inch. Therefore, clock bar 250 is always under single linear array 236 and a clock signal accordingly generated. This is illustrated by comparing the first position 254 of single linear array 236 with single linear array 236 at the second position 256 shown in dotted outline in Figure 12. Both standardized and custom bars of arbitrary length may thus be scanned. The scanning mode of Figure 12 will be used in preference to the point-and-click mode of Figure 11 when, for example, the bar code whether in standardized format or custom format, is too long to be included under the optical length of single linear array 236.

Figure 13 is a symbolic depiction of pen 210 used to scan a line of text 258. A general methodology usable with the present invention for text scanning is described in the copending application referenced above, which is herein incorporated by reference. One of the persistent problems in text scanning has been the loss of a portion of the first or last character in the text line. According to the invention, scanning pen 210 is placed to the left of a first character 260 in text line 258 by a predetermined distance 262 which is illustrated as the distance between CCD linear array 236 and the right edge 264 of pen 210. This predetermined position can easily be sighted and manually aligned by the user. The scanned pixels starting from position 266 to edge 264 are automatically discarded according to program control so that the retained pixel scans start from the left edge of first character 260 coincident with edge 264 and continue to the right. In this manner, it can be ensured that the

entire field of the first character is completely scanned and errors in the beginning of the scan line avoided.

The identical problem with respect to the last character 268 in text line 258 is illustrated in the diagrammatic depiction of Figure 14 wherein pen 210 is moved or scanned beyond last character 268 by a predetermined distance 270. Distance 270 in the illustrated embodiment is the distance between the left edge 272 of pen 210 and point 266 of single linear array 236, which is easily sighted and manually positioned by the user. Again, according to program control, the number of scanned pixels which occur in distance 270 are automatically discarded. This ensures that the complete field of last character 268 is completely scanned and end-line scan errors avoided.

Clocking and guiding of pen 210 along text line 258 is controlled by means of a ruler 274, similar in concept to that described in the copending related application incorporated above. In addition, ruler 274 of the present embodiment may include a plurality of bar code sections 276 of standardized or custom bar codes which can be also read by pen 210 either in the static or linear modes.

Many modifications and alterations may be made by one having ordinary skill in the art without departing from the spirit and scope of the invention. Therefore, it must be understood that the described embodiment has been set forth only for the purposes of illustration and example and should not be read to limit or restrict the invention which is defined by the following claims.

The invention is thus to be understood not only include an apparatus where character grouping and code assignments are made in a personal computer as described above, but also an apparatus where these operations are performed in hardware or in a software controlled processor separate or remote from the personal computer. The hardware describe above may be stand-alone or provided in an expansion card plugged into the personal computer to give the pen circuitry a direct connection to the computer bus. An external RS232 interface may be provided and used to transfer data into the personal computer where the pen circuitry is not directly coupled to the personal computer bus. An intermediate and portable memory, such as a portable hard disk or floppy disk drive, can also be coupled to the pen circuitry and then used to download the pixel data into the personal computer. This apparatus further contemplates the performance of all operations of the invention including storage of the serial code file and the dictionary in a separate or remote unit. The translation of the serial file into an ASCII file in a stand-alone, portable processor is also contemplated, which processor will then be later transported and used to download the translated ASCII file into a personal computer.

In the illustrated embodiment the scanning of horizontal lines of alphanumeric characters has been assumed. However, the invention is equally adaptable to

scanning any type of symbol including abstract mathematical or scientific symbols, or symbols from nonalphabetic languages such as pictographic or ideographic languages. The symbol further need not even be a graphic formed by human device, but may include the scanning of repetitive patterns which occur in nature.

The claims are to be construed not only to include the reasonable scope of the literal meaning of the words and terms used therein, but also to include elements not literally included if those elements are in whole or in part equivalent to the claims as a whole, elements in the claims, or subcombinations of elements in the claims. The claims are thus to be interpreted as equitably including all other embodiments which in essence incorporate the novel concept of the claims.

I claim:

1. An apparatus for scanning symbols disposed upon a sheet comprising:

means for detecting at least a line segment of pixels on said sheet;

means for parameterizing said detected line segment of pixels relative to a geometric position on said sheet along a predetermined curve; and

a housing for containing said means for detecting and for guiding said means for parameterizing, said housing being hand held and manually manipulatable for the purpose of scanning said symbols on said sheet,

whereby an inexpensive apparatus is provided for scanning conventional printed materials.

2. The apparatus of Claim 1 wherein said predetermined curve is a straight line and said symbols disposed on said sheet is a printed line of alphanumeric symbols.

3. The apparatus of Claim 2 wherein said means for parameterizing further comprises a ruler defining said straight line, said ruler being manually positioned on said sheet adjacent said printed line of symbols, said housing arranged and configured to slideably mount on said ruler, said ruler having a longitudinal length and said housing adapted to slide along said longitudinal length of said ruler over said printed line of symbols while otherwise being maintained in a predetermined position relative to said printed line of symbols.

4. The apparatus of Claim 3 wherein said ruler comprises an indicia area defined along said longitudinal length of said ruler, said indicia area providing detectable indicia wherein said geometric position of said line of pixels within said printed line of symbols may be determined.

5. The apparatus of Claim 4 wherein said indicia area is a plurality of diagonally inclined bars disposed on said ruler having contrasting reflectivity, said bars being diagonally inclined in a direction along said longitudinal length of said ruler.

6. The apparatus of Claim 5 wherein said means for parameterizing comprises means for detecting and measuring movement of said apparatus along said longitudinal length of said ruler relative to said plurality of diagonal bars in said indicia area on said ruler.

7. The apparatus of Claim 3 wherein said ruler is comprised of a vertical leg and a horizontal foot, said housing being adapted to be guided by said vertical leg, said horizontal foot being adapted to being disposed on said sheet and positioned relative to said printed line of symbols, said ruler further comprising means for displaying to a user at least part of said printed line of symbols to be scanned.

8. The apparatus of Claim 7 wherein said means for displaying said printed line of symbols comprises means for optically transmitting an image of said printed line of symbols adjacent to said ruler to a predetermined surface defined on said ruler, printed lines of symbols on said sheet adjacent to said ruler which are not in a position to be scanned by said apparatus being obscured from view by said means for displaying.

9. The apparatus of Claim 1 further comprising means for illuminating said symbols on said sheet.

10. The apparatus of Claim 1 wherein said means for detecting comprises optical means for focusing said symbols on said sheet and a charged coupled detecting device having at least one line of pixel detectors defined therein, said means for focusing an image of said symbols on said sheet onto said at least one line of pixel detectors in said charge coupled device.

11. The apparatus of Claim 1 further comprising means for isolating a pixel map of at least one symbol scanned by said apparatus from said sheet and means for uniquely correlating to said isolated pixel map a code, wherein neither said means for isolating nor said means for uniquely correlating identify said symbol as corresponding to any human readable symbol, but only isolate and correlate said symbol as being a unique graphic pattern.

12. The apparatus of Claim 11 further comprising means for establishing a plurality of isolated pixel maps of graphic patterns with uniquely correlated codes from said printed line of symbols scanned from said sheet.

13. The apparatus of Claim 12 further comprising means for scanning a plurality of symbols on said sheet in a sequence as said symbols appear on said sheet and for storing a corresponding sequence of said uniquely correlated codes.

14. The apparatus of Claim 13 further comprising means for translating said sequence of codes corresponding to said sequence of symbols on said sheet into a standardized code corresponding at least in part to human readable alphanumeric characters.

15. The apparatus of Claim 14 wherein said standardized codes are ASCII codes for alphanumeric characters and graphic symbols.

16. A method of scanning symbols on a sheet for input and processing in a computer comprising the steps of:

imaging at least a line segment from a field of view on said sheet whereon said symbols are disposed;

establishing a corresponding plurality of pixels representing said imaged line segment; and

generating a parameter indicative of the geometric position of said imaged line segment from said sheet

whereby data derived from said signals may be processed to form bit map images of said symbols from said sheet.

17. The method of Claim 16 further comprising the steps of:

temporarily storing a plurality of sequences of said pixels ordered according to said parameter signal;

grouping said plurality of pixels to isolate associated pixels corresponding to a unique graphic pattern; and

assigning an arbitrary number to said group of pixels of said isolated graphic patterns.

18. The method of Claim 17 further comprising repeating said steps of temporarily storing, grouping and assigning to create in memory a dictionary of unique graphic patterns and unique arbitrary codes assigned thereto.

19. The method of Claim 18 further comprising the steps of:

repeating said steps of imaging, establishing and generating to scan a line of symbols printed on said sheet; and

storing only said arbitrary codes in a sequence corresponding to isolated unique graphic patterns in said line of symbols in a corresponding sequence as said symbols appear in said line of symbols, said step of storing being performed after said dictionary is established for symbols in said line.

20. The method of Claim 19 further comprising the step of translating said sequence of codes into standardized codes of human readable alphanumeric characters and graphic symbols.

21. The method of Claim 16 wherein said step of generating said parameter signal comprises the step of manually moving a light scanning pen along a ruler disposed adjacent to a line of symbols to be scanned, said light pen reading a plurality of indicia markers on said ruler to provide said parameter signal corresponding to position of said light pen on said ruler relative to said line of symbols on said sheet.

22. The method of Claim 21 further comprising the step of accepting said pixels corresponding to said imaged line only if said light pen is moved into new fields of view along said ruler as determined by generation of said parameter signal indicative of advancement of said light pen into fields of view, pixels being generated as to all previously scanned fields of view being disregarded.

23. An apparatus for providing input to a computer from an off-screen medium comprising:

a single linear array of optical detectors; and

means for selectively configuring said single linear array of detectors in one of a plurality of input modes to optically read information from said off-screen medium,

whereby a universal input device for said computer is provided.

24. The apparatus of Claim 23 wherein said plurality of input modes comprises at least a static mode input, said static mode input being defined as input through said single linear array of detectors without relative movement of said single linear array with respect to said off-screen medium.

25. The apparatus of Claim 23 wherein said plurality of input modes comprises at least one linear dimensional mode, said linear dimensional mode being defined as relative movement of said single linear array of detectors with respect to said off-screen medium in a line of direction.

26. The apparatus of Claim 24 wherein said plurality of input modes comprises at least one linear dimensional mode, said linear dimensional mode being defined as relative movement of said single linear array of detectors with respect to said off-screen medium in a line of direction.

27. The apparatus of Claim 23 wherein said plurality of input modes comprises at least a two-dimensional input mode, said two-dimensional input mode being defined as relative motion of said single linear array of detectors in at least two noncolinear directions with respect to said off-screen medium.

28. The apparatus of Claim 24 wherein said plurality of input modes comprises at least a two-dimensional input mode, said two-dimensional input mode being defined as relative motion of said single linear array of detectors in at least two noncolinear directions with respect to said off-screen medium.

29. The apparatus of Claim 26 wherein said plurality of input modes comprises at least a two-dimensional input mode, said two-dimensional input mode being defined as relative motion of said single linear array of detectors in at least two noncolinear directions with respect to said off-screen medium.

30. The apparatus of Claim 27 wherein said off-screen medium comprises a grid, said grid comprising in turn a plurality of horizontal lines and a plurality of diagonal lines, said horizontal lines being detected by said means through said single linear array of optical detectors to detect relative motion of said apparatus with respect to said off-screen medium in a direction perpendicular to said horizontal lines, detection of relative movement with respect to said diagonal lines being interpreted by said means to indicate motion of said apparatus parallel to the said horizontal lines, so that said apparatus is operable as a mouse input device.

31. The apparatus of Claim 27 wherein movement of said single linear array of detectors across said off-screen medium is interpreted by said means as a pixel map of handwriting.

32. The apparatus of Claim 27 wherein said off-screen medium comprises a plurality of unique positions, each of said positions corresponding to a character/command, said means identifying said unique position and generating a digital code corresponding to said character/command.

33. The apparatus of Claim 24 wherein said off-screen medium comprises bar codes, said means further comprising an activating switch, said single linear array of detectors being disposed across one of said bar codes and said activating switch being activated to read said bar code upon switch activation without movement of said single linear array of detectors across said bar code.

34. The apparatus of Claim 33 wherein said bar codes are user-defined.

35. The apparatus of Claim 33 wherein said bar codes have a predetermined standardized definition.

36. The apparatus of Claim 25 wherein said off-screen medium comprises bar codes having a plurality of bars, said bar codes including at least one clock bar, said means for selectively detecting said clock bar to asynchronously time detection of remaining bars in said bar code as said single linear array of detectors are moved thereacross, so that the rate of motion of said single linear array of detectors with respect to said bar codes may be arbitrary.

37. The apparatus of Claim 30 wherein said off-screen medium comprises said grid and a plurality of bar code patterns readable by said apparatus, at least one of said plurality of bar code patterns corresponding to an instruction for controlling said computer.

38. The apparatus of Claim 30 wherein said horizontal lines of said grid comprise a plurality of horizontal lines of a first predetermined thickness and spaced apart from each other by a dimension less than the optical length of said single linear array of detectors, and wherein said plurality of diagonal lines comprise a plurality of diagonal line segments disposed between each of said horizontal lines, said diagonal line segments having a second thickness, said second thickness being distinguishable by said means from said first thickness.

39. The apparatus of Claim 25 wherein said off-screen medium comprises at least one line of text having at least one character in said line, and

wherein said apparatus further comprises:

a ruler for guiding said single linear array of detectors in a predetermined relative position with respect to said line of text, and

positioning means for positioning said single linear array detectors at a predetermined first position relative to a corresponding first character position in said line of text and a predetermined last character position in said line of text,

so that the entire line of text is reliably scanned.

40. The apparatus of Claim 39 wherein said positioning means disposes said single linear array of detectors to the left of said first character position by a predetermined scan distance and positions said last position of said single linear array of detectors to the right of said last character position by a predetermined scan distance, and

wherein said means for selectively providing input further selectively ignores output from said single linear array of detectors for said predetermined scanned distances to the left of said first character position and to the right of said last character position to ensure that the entire length of said text line is fully and reliably scanned.

41. The apparatus of Claim 39 wherein said ruler further comprises a plurality of positions having bar codes disposed thereon readable by said apparatus.

42. A method of providing a universal input device for a computer comprising the steps of:

providing a single linear array of detectors;

generating an output from said single linear array of detectors from an off-screen medium over which said detectors are disposed; and

selectively interpreting said output from said single linear array of detectors according to one of a plurality of modes, said plurality of modes comprising a static mode wherein said single linear array of detectors and off-screen medium are relatively fixed with respect to each other during generation of said output, a linear mode wherein said single linear array of detectors are moved with respect to said off-screen medium in a single direction during said step of generating said output, and a two-dimensional mode wherein said single linear array of detectors are moved in two noncolinear directions with respect to said off-screen medium during said step of generating said output,

whereby said universal input device is selectively operated as a point-and-click bar code reader, bar code scanner, mouse, handwriting input, and text scanner.

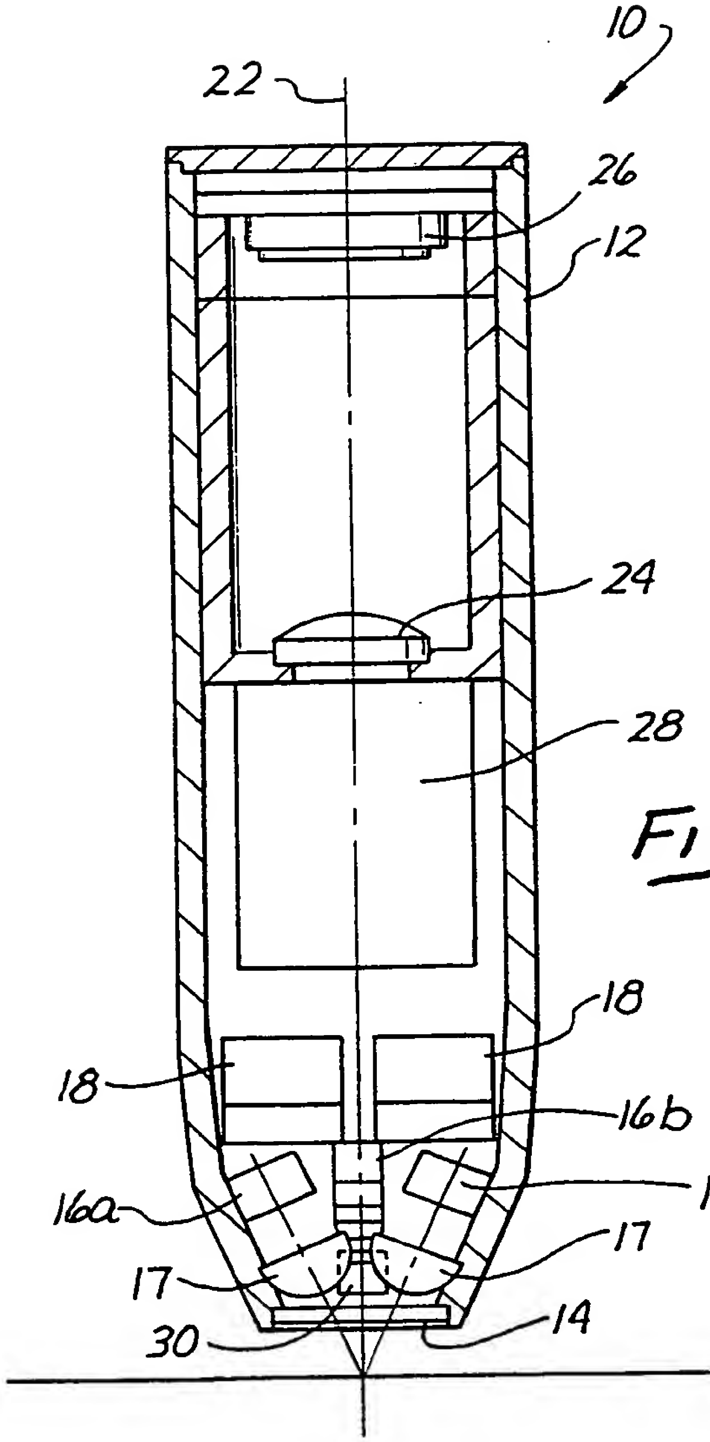
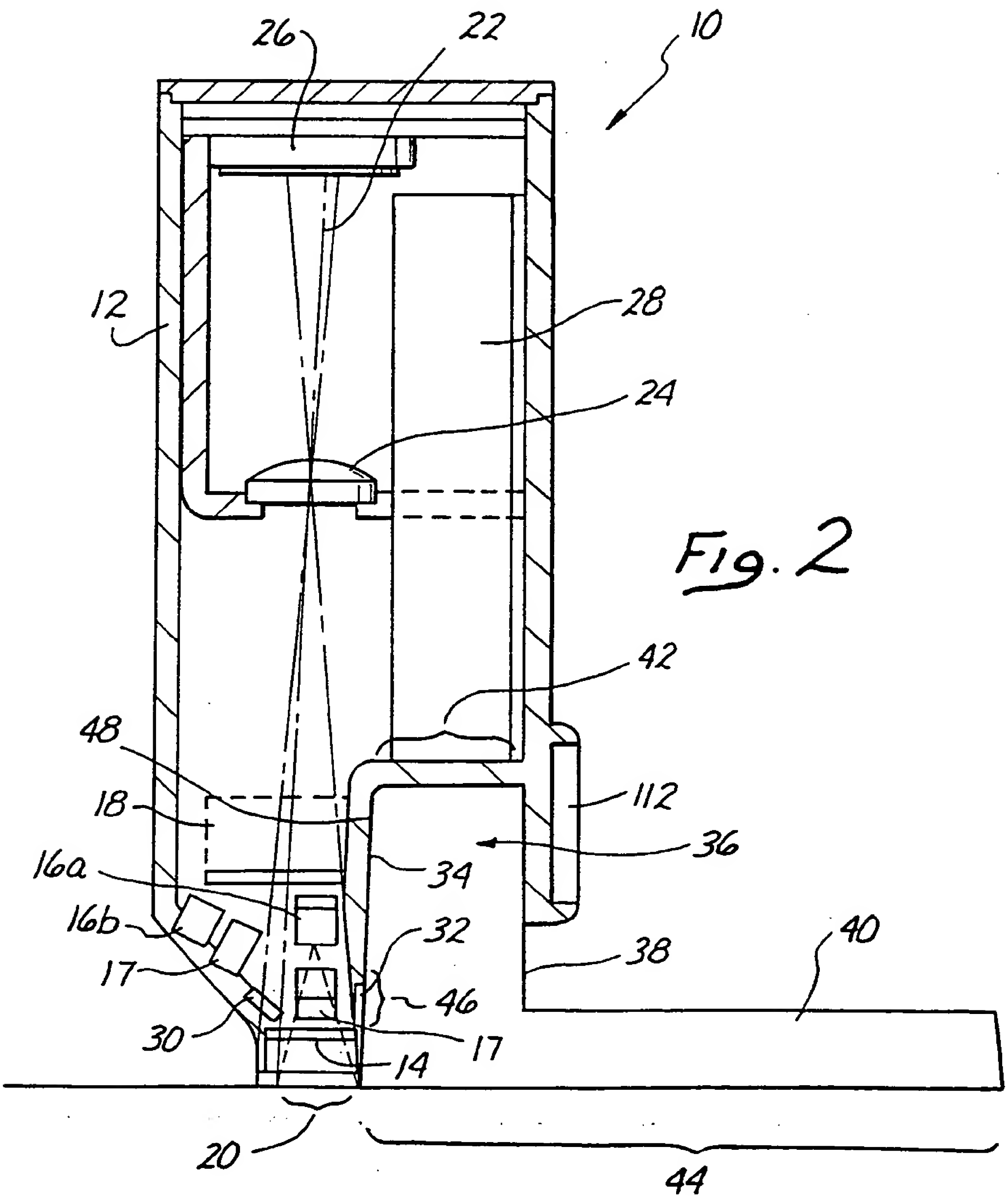


Fig. 1


10
26
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12
28
24
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16a
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16b
32
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17
14
20
44

Fig. 2

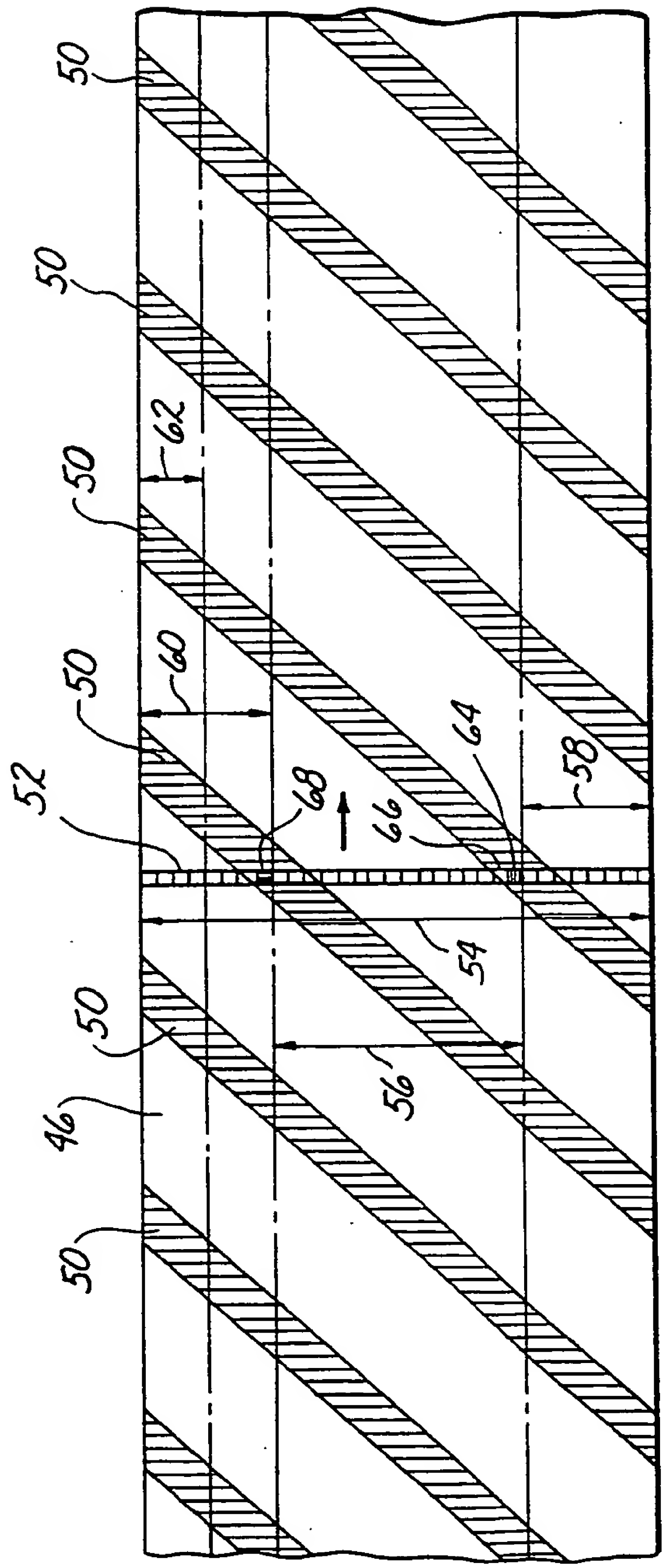


Fig. 3

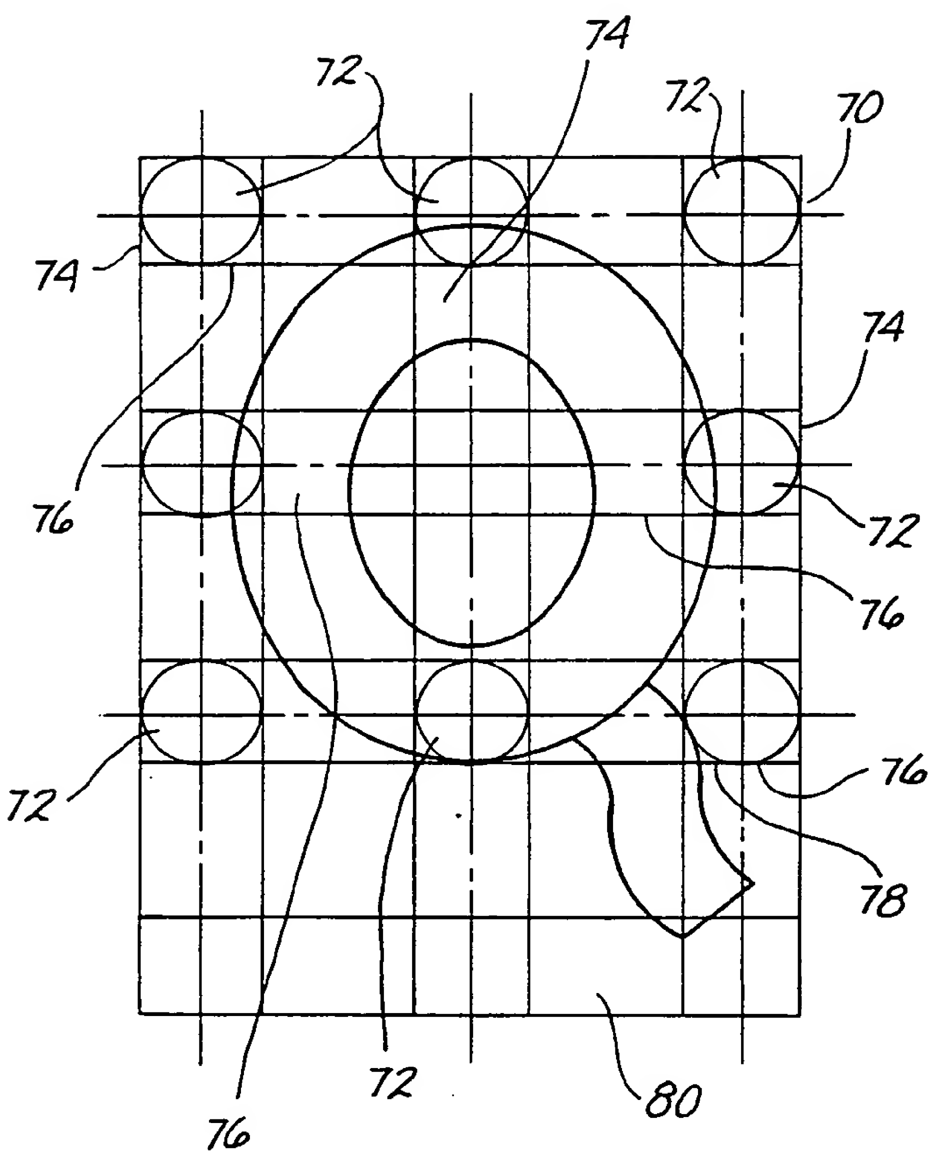


Fig. 4

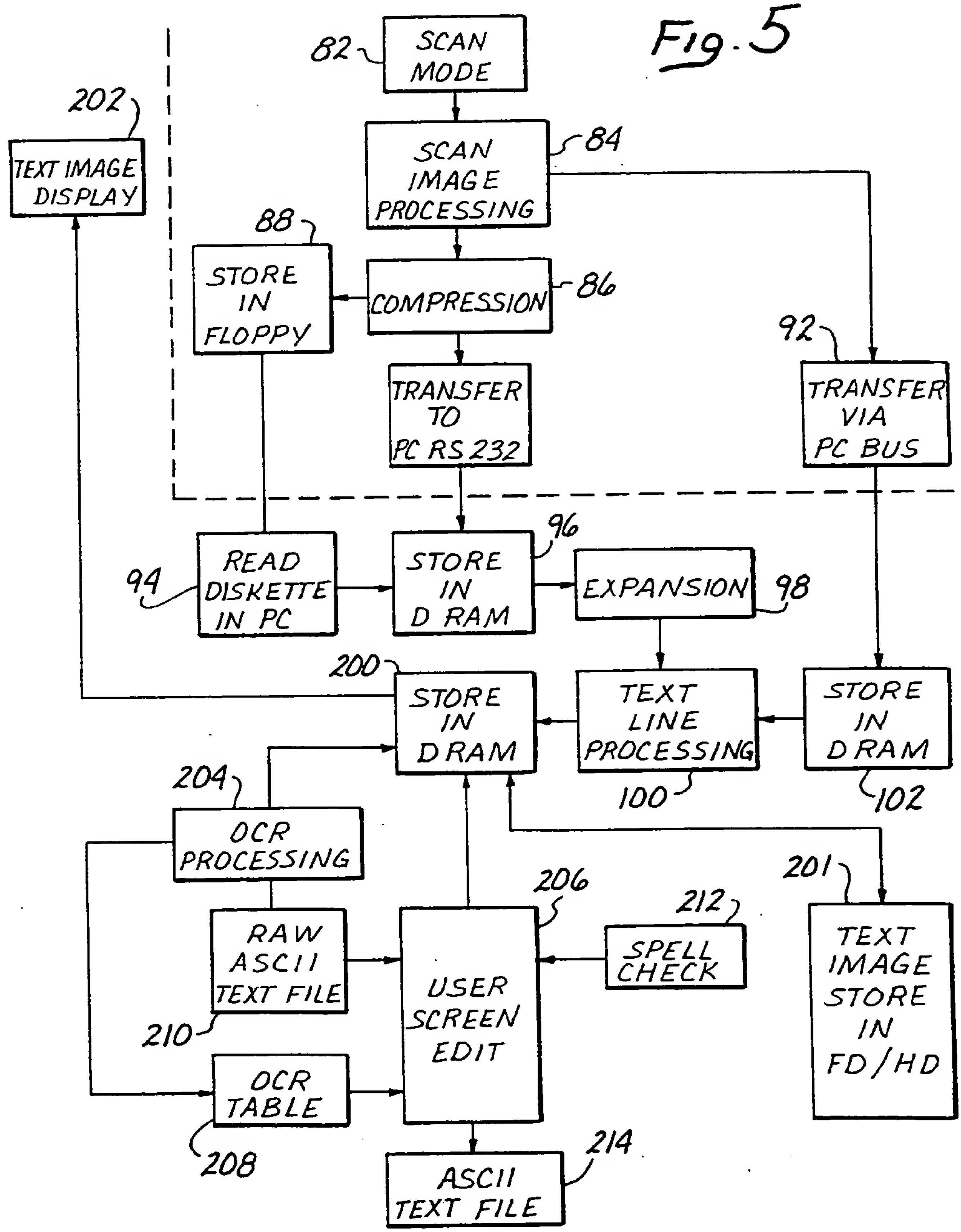
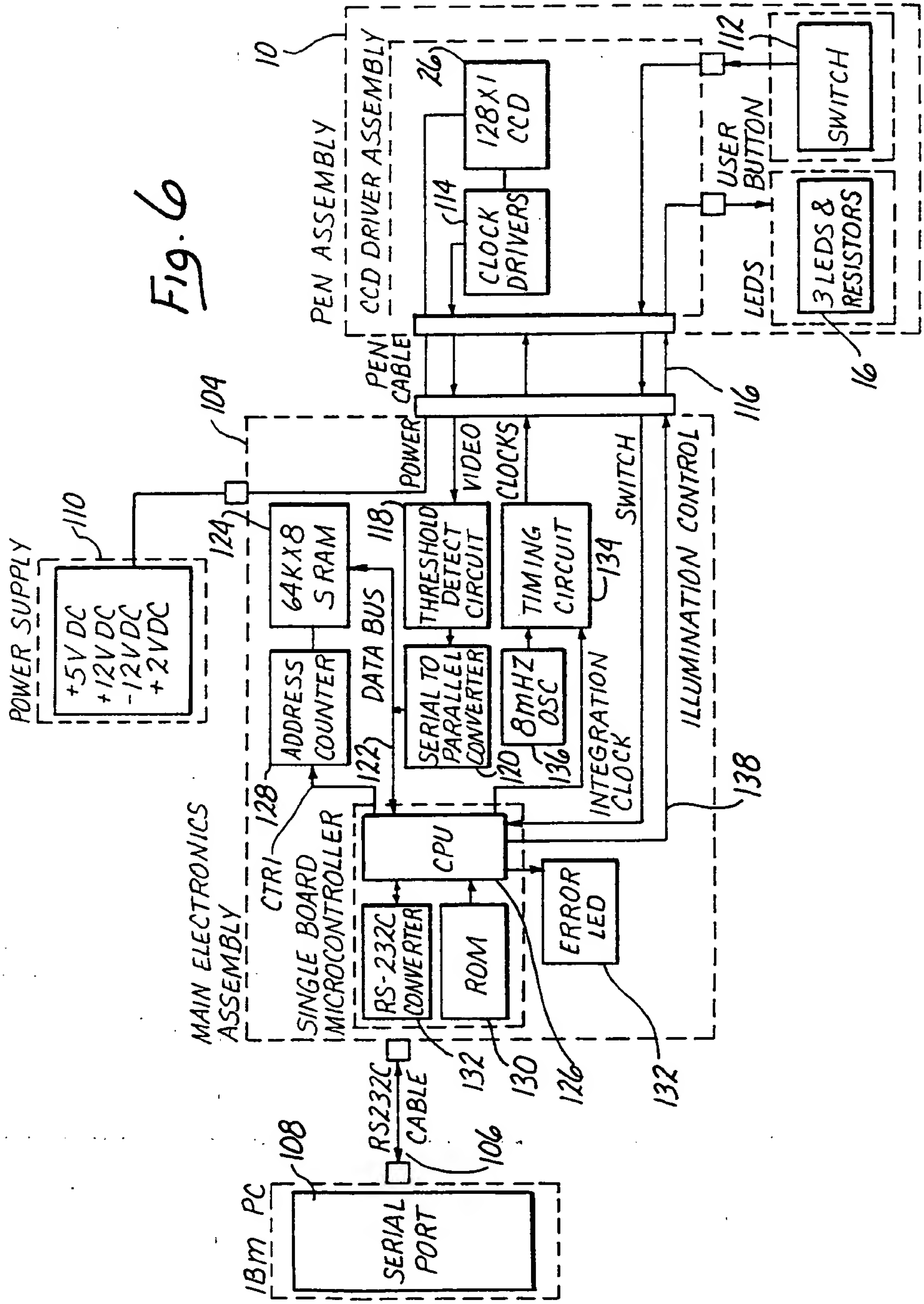

82
SCAN MODE
84
SCAN IMAGE PROCESSING
86
COMPRESSION
88
STORE IN FLOPPY
TRANSFER TO PC RS 232
92
TRANSFER VIA PC BUS
202
TEXT IMAGE DISPLAY
94
READ DISKETTE IN PC
96
STORE IN D RAM
EXPANSION
98
200
STORE IN DRAM
TEXT LINE PROCESSING
100
STORE IN DRAM
102
204
OCR PROCESSING
206
212
SPELL CHECK
201
RAW ASCII TEXT FILE
210
USER SCREEN EDIT
TEXT IMAGE STORE IN FD/HD
OCR TABLE
208
214
ASCII TEXT FILE

Fig. 5


PEN ASSEMBLY
CCD DRIVER ASSEMBLY
128X1 CCD
CLOCK DRIVERS
USER BUTTON
SWITCH
LEDS
3 LEDS & RESISTORS
PEN CABLE
POWER
VIDEO
CLOCKS
SWITCH
ILLUMINATION CONTROL
POWER SUPPLY
+5V DC
+12V DC
-12V DC
+2V DC
64KX8 SRAM
ADDRESS COUNTER
DATA BUS
THRESHOLD DETECT CIRCUIT
SERIAL TO PARALLEL CONVERTER
TIMING CIRCUIT
8mHZ OSC
INTEGRATION CLOCK
MAIN ELECTRONICS ASSEMBLY
SINGLE BOARD MICROCONTROLLER
CTRL
CPU
RS-232C CONVERTER
ROM
ERROR LED
RS232C CABLE
IBM PC
SERIAL PORT
10
26
112
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126
132
106
108

Fig. 6

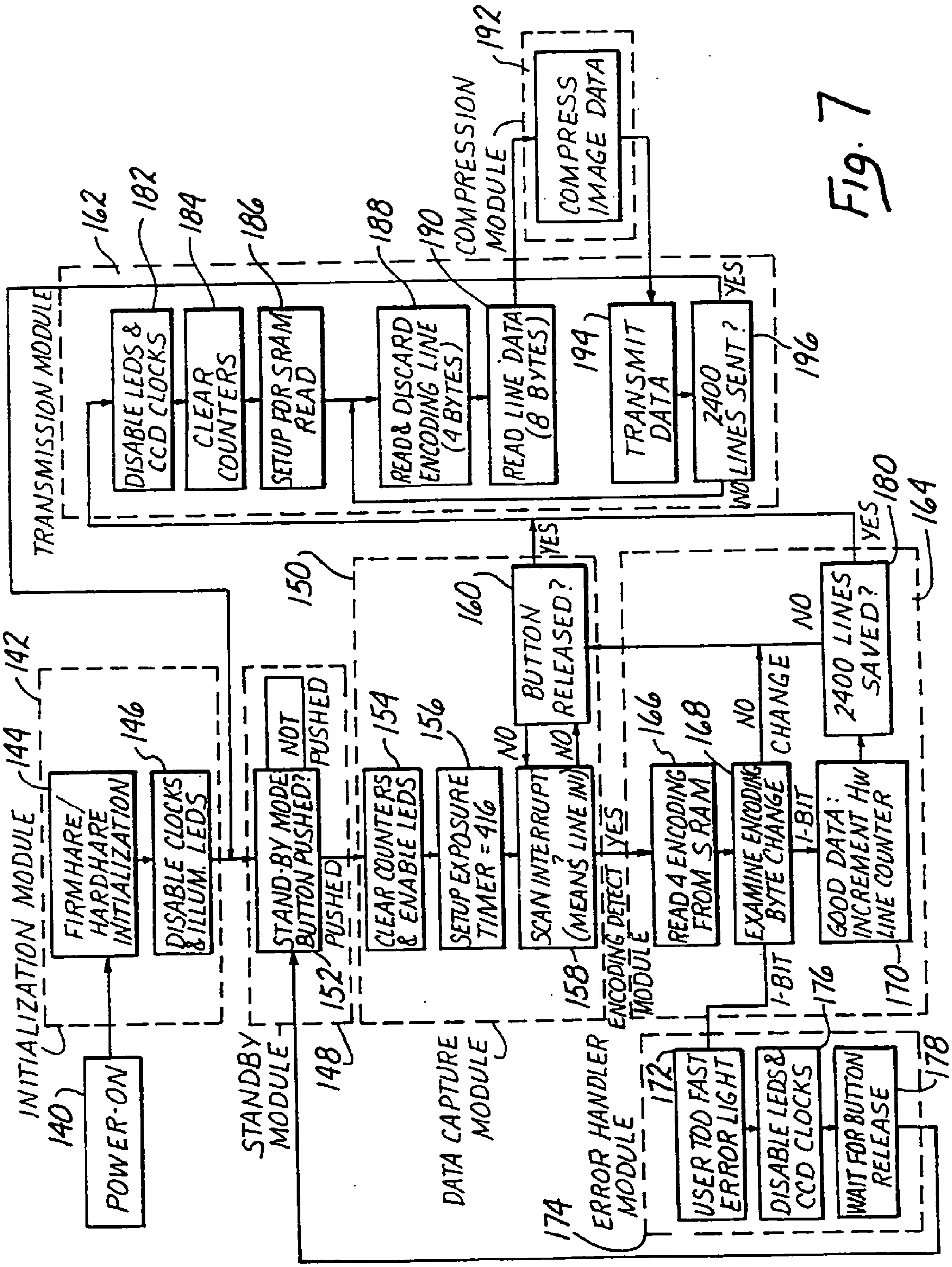
POWER-ON
140
INITIALIZATION MODULE
142
144
FIRMWARE/ HARDWARE INITIALIZATION
146
DISABLE CLOCKS & ILLUM. LEDS
STANDBY MODULE
148
STAND-BY MODE BUTTON PUSHED?
NOT PUSHED
PUSHED
152
DATA CAPTURE MODULE
150
154
CLEAR COUNTERS & ENABLE LEDS
156
SETUP EXPOSURE TIMER = 416
SCAN INTERRUPT ? (MEANS LINE IN)
158
NO
YES
160
BUTTON RELEASED?
ENCODING DETECT MODULE
164
166
READ 4 ENCODING FROM SRAM
168
EXAMINE ENCODING BYTE CHANGE
CHANGE
1-BIT
GOOD DATA: INCREMENT HW LINE COUNTER
170
2400 LINES SAVED?
180
ERROR HANDLER MODULE
174
172
USER TOO FAST ERROR LIGHT
176
DISABLE LEDS & CCD CLOCKS
178
WAIT FOR BUTTON RELEASE
TRANSMISSION MODULE
162
182
DISABLE LEDS & CCD CLOCKS
184
CLEAR COUNTERS
186
SETUP FOR SRAM READ
188
READ & DISCARD ENCODING LINE (4 BYTES)
190
READ LINE DATA (8 BYTES)
194
TRANSMIT DATA
196
2400 LINES SENT?
COMPRESSION MODULE
192
COMPRESS IMAGE DATA

Fig. 7

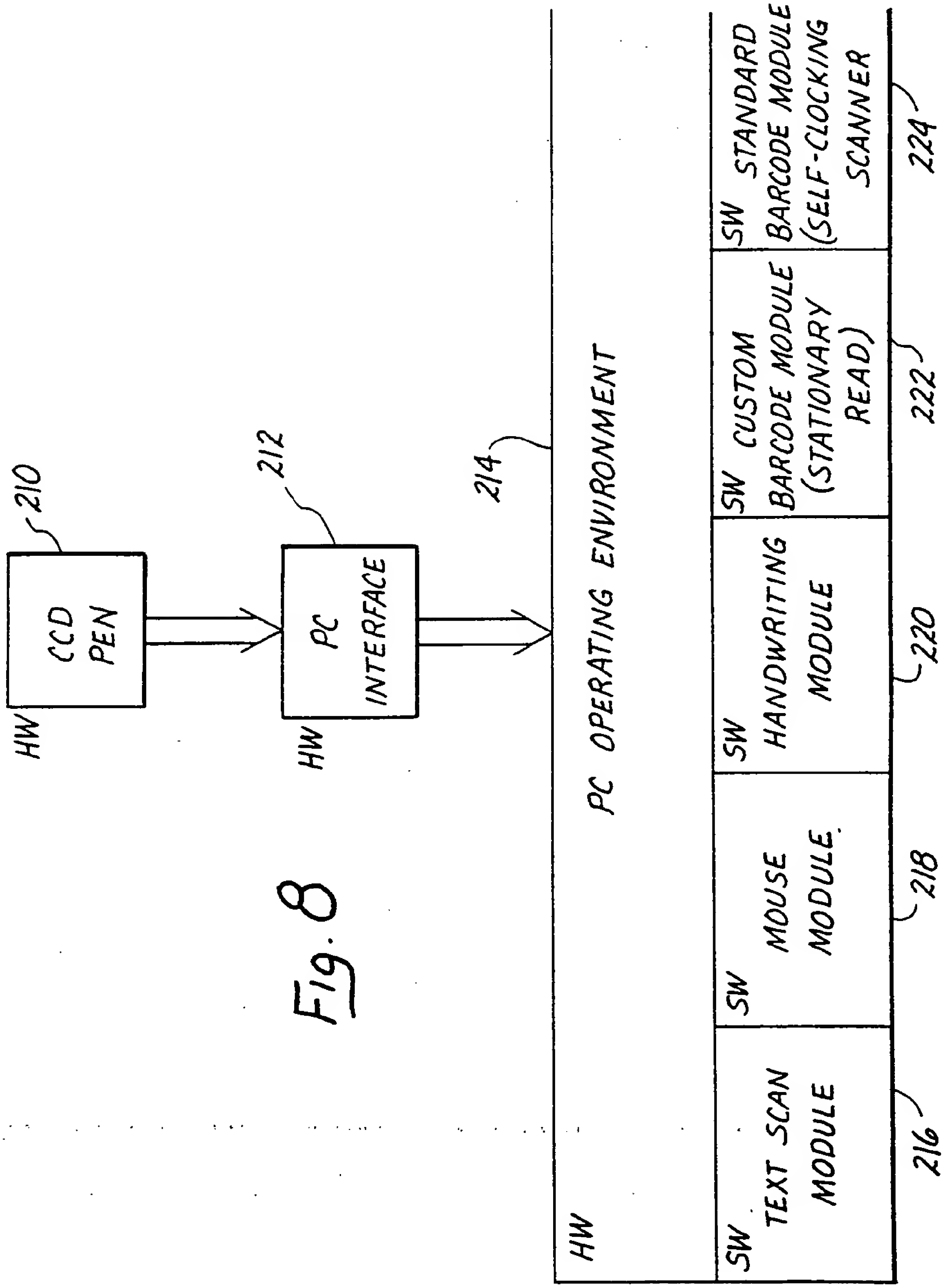
CCD PEN
HW
210
PC INTERFACE
HW
212
214
PC OPERATING ENVIRONMENT
HW
SW TEXT SCAN MODULE
216
SW MOUSE MODULE
218
SW HANDWRITING MODULE
220
SW CUSTOM BARCODE MODULE (STATIONARY READ)
222
SW STANDARD BARCODE MODULE (SELF-CLOCKING SCANNER
224

Fig. 8

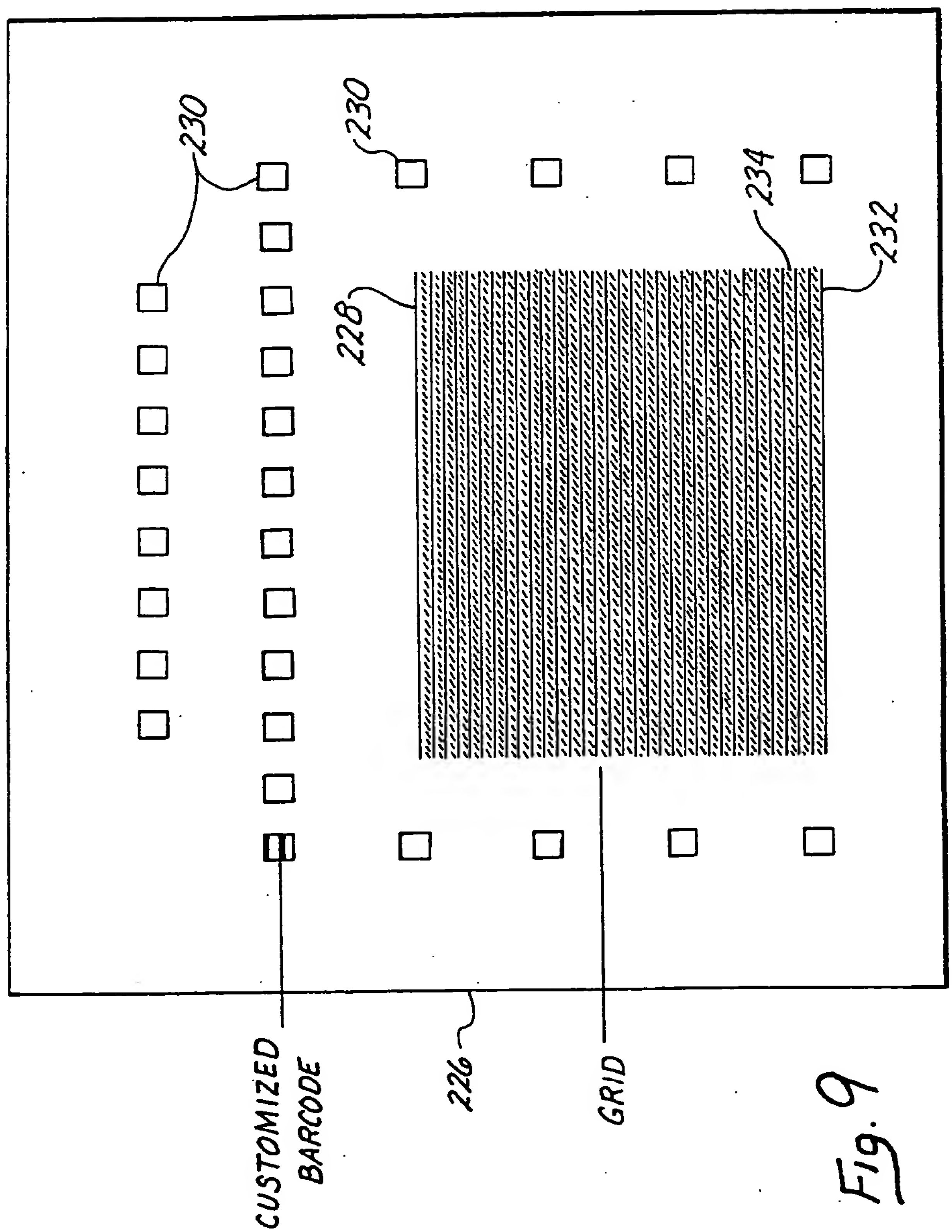

Fig. 9

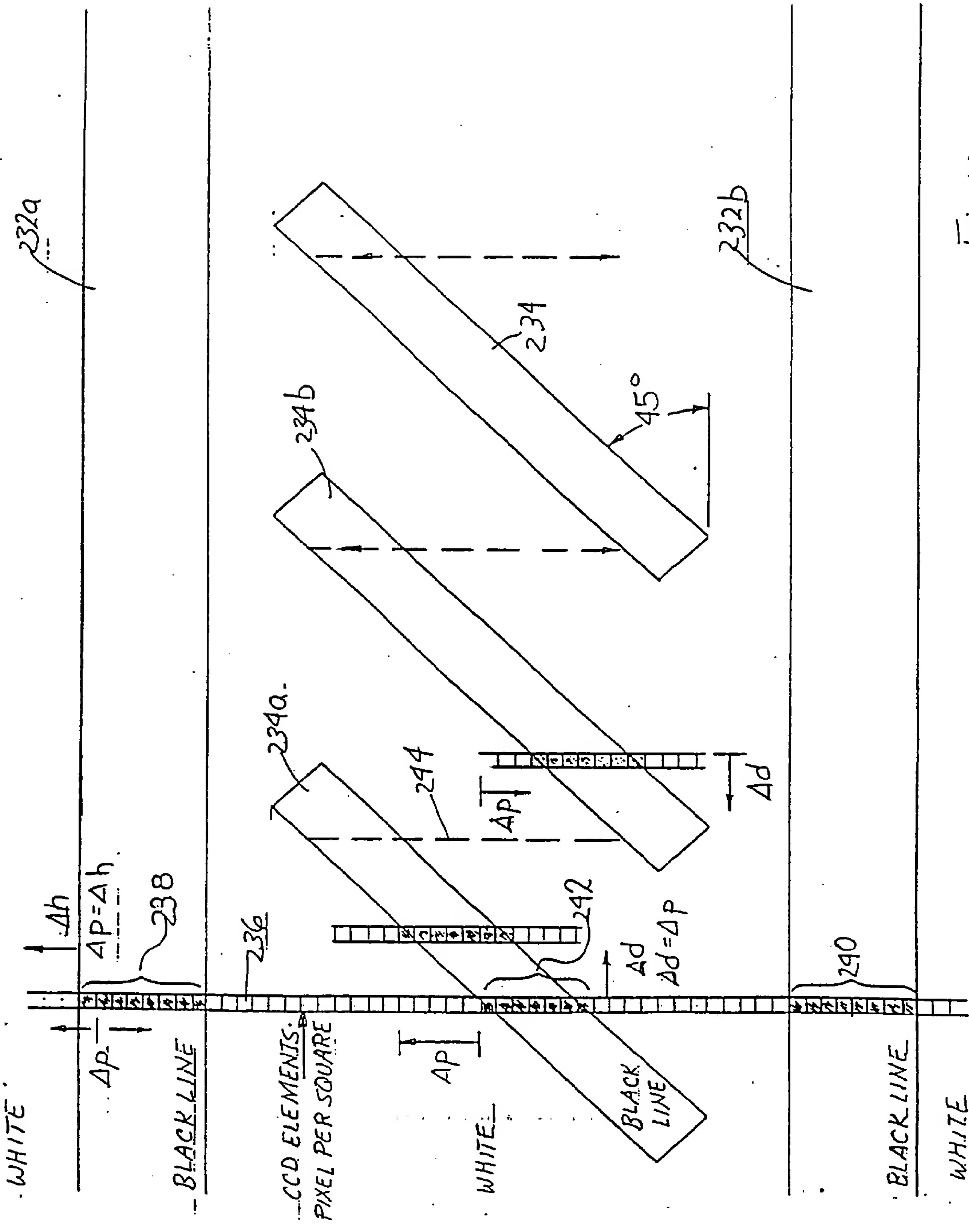
232a
232b
234
234a
234b
45°
236
238
240
242
244
Δh
ΔP = Δh
ΔP
Δd
Δd = ΔP
WHITE
BLACK LINE
CCD ELEMENTS
PIXEL PER SQUARE
WHITE
BLACK LINE
BLACK LINE
WHITE

Fig 10

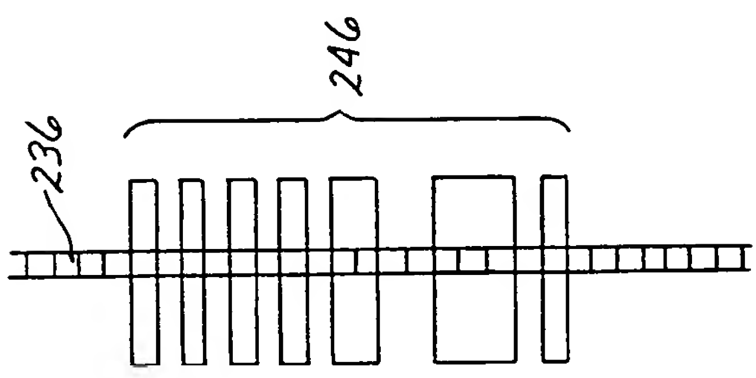

Fig. 11

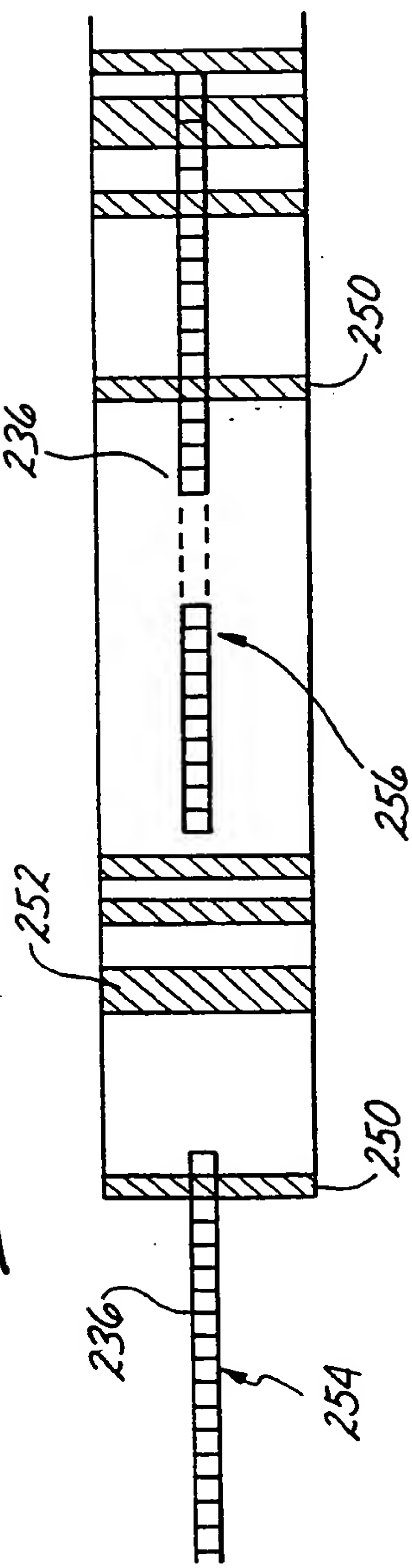

Fig. 12

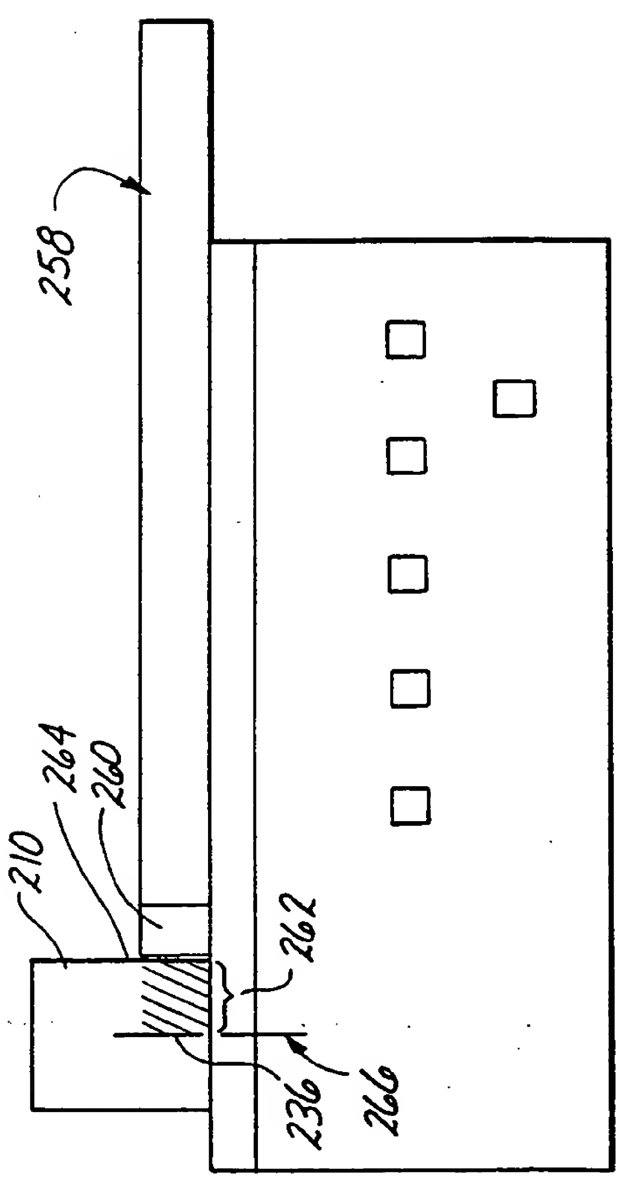

Fig. 13

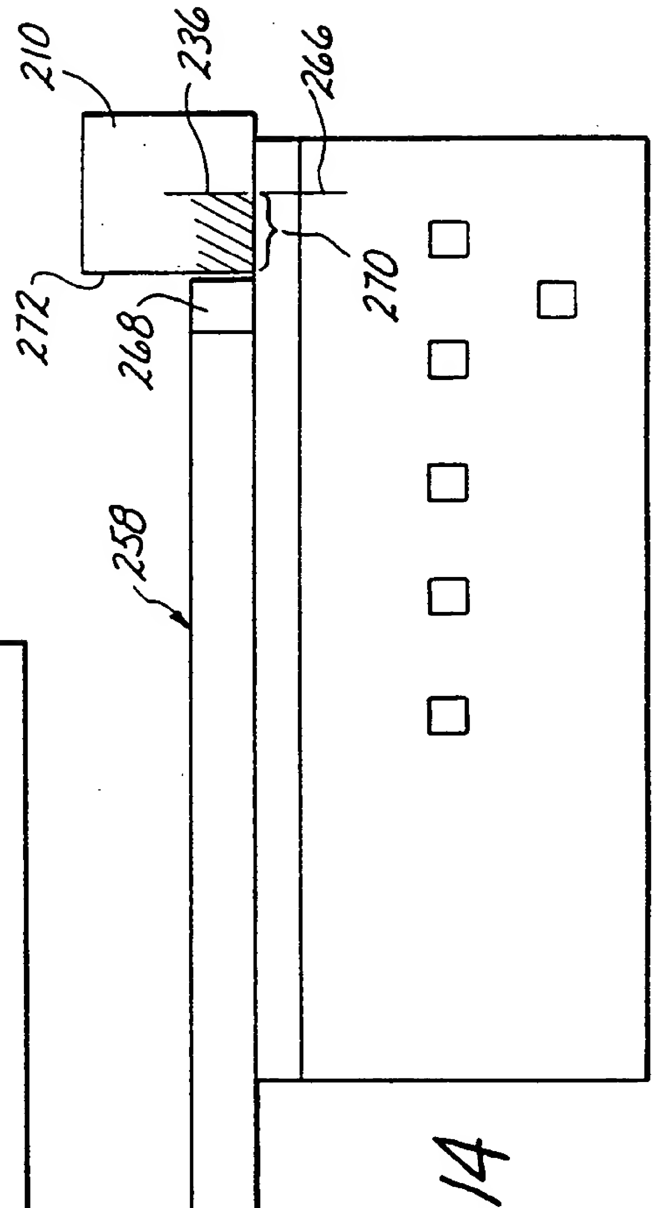

Fig. 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/04237

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : G06K 9/22
US CL :382/59

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 382/59, 62,65,67,68,61,56,14; 358/473,474,486,488 235/436,440,472,454,466,495; 340/708,710; 250/221

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

None

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A, 4,553,035 (MALINSKY et al) 12 November 1985. See column 3, lines 12-15, and 23-50.	1-7 and 10
X	US,A, 5,058,188 (YONEDA) 15 October 1991. See Figs 1 and 2 and Column 1, lines 34-62; column 5, lines 8-30; column 9, lines 19-23; and column 4, lines 51-54.	1-7, 9-10;16 and 21
Y	US,A, 4,606,069 (JOHNSEN) 12 August 1986. See column 3, lines 26-38; column 1, lines 46-52; and column 5, lines 31-33.	11-13

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 JULY 1993	07 SEP 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer MICHAEL R. CAMMARATA
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/04237

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A, 4,048,617 (NEFF) 13 September 1977. See column 3, lines 57-66 and column 4, lines 48-50.	22
A	US,A, 4,641,357 (SATOH) 03 February 1987. See Fig. 1 element 5	1-42
P/A	US,A, 5,130,847 (TSUJIOKA) 14 JULY 1992. See abstract	1-42
A	US,A, 4,797,544 (MONTGOMERY) 10 January 1989. See Fig 12	1-42
X	US,A, 4,860,377 (ISHIGAKI) 22 August 1989. See Figs. 4, 9, 10 and 11 and column 2, lines 57-69 and column 3, lines 35-49.	23-32,38,39 and 42
Y	US,A, 4,825,058 (POLAND) 25 April 1989. See Fig 2 and column 1, lines 20-45.	33-37,40 and 41
A	US,A, 4,411,016 (WAKELAND) 18 October 1983. See Figs 1-3.	23-42
A	US,A, 4,521,772 (LYON) 04 January 1985. See Figs 2, 6 and 12	23-42
A	US,A, 4,942,621 (ANGWIN) 17 July 1990. See Fig 2.	23-42